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EVALUATION OF HISTORIC DESERT BIGHORN SHEEP RANGES

NEW MEXICO DEPARTMENT OF GAME AND FISH

Final Report

Prepared by

Andrew V. Sandoval

Desert Bighorn Sheep Project Leader

July 1979

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PRELIMINARY SURVEY REPORT
ON THE EVALUATION OF HISTORIC DESERT BIGHORN SHEEP RANGES

NEW MEXICO DEPARTMENT OF GAME AND FISH

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Final Report

Prepared by

Andrew V. Sandoval

Desert Bighorn Sheep Project Leader

July 1979

ABSTRACT

Seventeen historic desert bighorn sheep (Ovis canadensis mexicana Merriam) ranges were qualitatively evaluated to determine their suitability for the re-establishment of desert bighorn populations. The method for evaluating habitat factors that significantly affect desert bighorn was based on environmental characteristics and degree of competition. The method consisted of a series of components which, in combination, subjectively determined the suitability of an area as a potential release site. Each component was assigned a numerical value in relation to its influence in the overall criterion that constitutes potential desert bighorn habitat.

The ranges were categorized into three general regions based on climatic conditions, distinct floral and faunal components and possible competition that might seemingly preclude successful reintroductions of desert bighorn.

Based on the availability of suitable habitat, minimal disturbance by the human element and remote possibility of invasion by non-indigenous wildlife, the following ranges were selected for quantitative studies to determine their full potential for perpetuating populations of desert bighorn sheep: 1) Alamo Hueco Mountains, 2) Peloncillo Mountains, 3) Fra Cristobal Mountains, 4) Ladron Mountains, 5) San Mateo Mountains, and 6) Cooke Range.

ACKNOWLEDGMENTS

This study would have not been accomplished without the cooperation and assistance of numerous organizations and individuals. The study was a cooperative effort between the U.S. Department of the Interior - Bureau of Land Management, the U.S. Department of Agriculture - Forest Service, and the New Mexico Department of Game and Fish.

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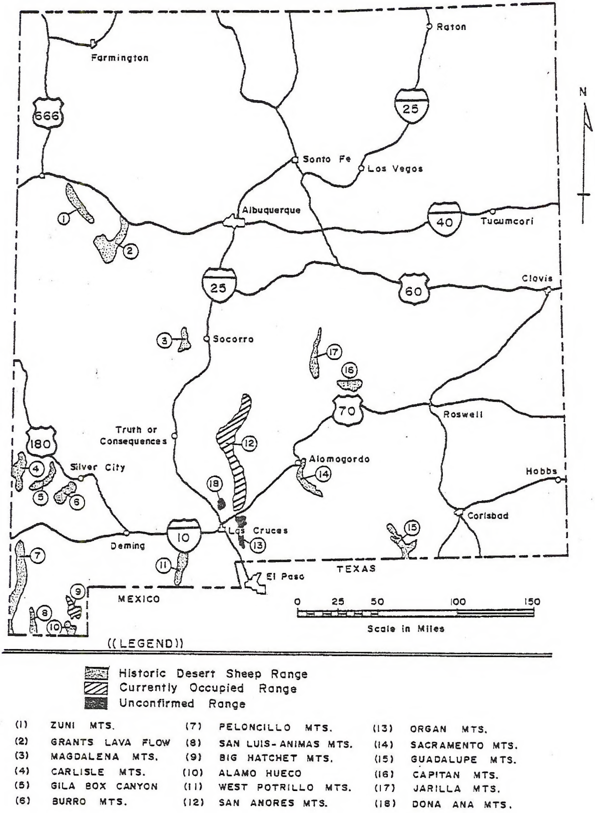


Figure 1. Past and present distribution of Mexican bighorn sheep in New Mexico.

(Gates 1972).

During January of 1972, five desert bighorn sheep were captured in the Loma Prieta range of Sonora, Mexico. This area was selected because the sheep in this locale and sheep indigenous to New Mexico are of common ancestry, and the terrain lends itself to capturing sheep from rotary-winged aircraft (Gates 1972). Within a month after their release into the Red Rock enclosure, each of the ewes gave birth to lambs. One lamb died and the four remaining (3 males and a female) were successfully handraised (Hightower and Gates 1973). The next addition to the group was a two-year-old ram taken from the San Andres Refuge during the summer of 1972 and placed with the ewes from Mexico. This ram later broke its neck in the paddock during a severe thunderstorm (Montoya 1973). Two mature rams (1 7-year-old and a 6-year-old) were taken from the San Andres Refuge in August 1972. The larger ram was placed with the ewes and apparently battered himself and several ewes to death in his attempt to escape (Montoya 1973).

The Red Rock captive herd was supplemented in late 1972 with five ewes and again in December 1975 with an additional eight ewes taken from the San Andres Refuge. At the date of this report, July 1979, there are 49 bighorn of Mexican and New Mexican origin or their crosses in the enclosure.

Objectives

The New Mexico Department of Game and Fish, in cooperation with the Bureau of Land Management and the Forest Service, is attempting to reestablish desert bighorn on their historic ranges where habitat conditions and human-related activities are, or can be, made compatible with the sheep. The objectives of this study were to determine which areas of historic desert bighorn sheep ranges in New Mexico have the highest potential for the reestablishment

and perpetuation of a bighorn population(s), and to evaluate and rank selected areas in order of suitability as desert bighorn habitat.

Methods

Seventeen historic desert bighorn sheep ranges were qualitatively evaluated in order of suitability as bighorn habitat. In order to obtain the necessary information for establishing selection criteria and a basis for correlation in the location of desert bighorn reintroduction areas, a qualitative evaluation of environmental conditions and trends with emphasis on the ecosystem of the desert bighorn was undertaken.

Topographic and planimeteric maps of each of the study areas were obtained and reviewed to acquaint the author with topographic features, location of water sources, and accessibility. Prior to initiating field activities, aerial surveys utilizing fixed-wing aircraft were conducted in the various study areas. A Cessna 182 was used initially; however, this craft proved to be underpowered for flying in precipitous terrain. A Cessna 337 Skymaster "push-pull" type similar to the New Mexico Game and Fish Department aircraft was used more effectively to fly in mountainous areas.

Field activities, initiated in September 1977 and continued through May 1978, varied from three days in the Florida and Little Hatchet Mountains to two weeks in the Guadalupe and Peloncillo Mountains. Travel within the study areas was mostly on foot. The procedure was to cover as much area as possible and delineate potential bighorn habitat. Habitat components were subjectively assigned numerical values in relation to their influence in the overall criteria that constitute desert bighorn habitat, and recorded on data sheets (Figure 2).

A modification of the numerical scoring method proposed by Hansen (1971)

DESERT BIGHORN RE-INTRODUCTION

NEW MEXICO DEPARTMENT OF GAME AND FISH

CLASSIFYING DESERT BIGHORN HABITAT

Mountain Range __________

Section __________

Township __________

Range __________

TOOL I NATURAL TOPOGRAPHY (Maximum 20) __________

TOOL II VEGETATION TYPE (Maximum 20) __________

TOOL III ANNUAL PRECIPITATION (Maximum 10) __________

TOOL IV EVAPORATION PER WEEK (Maximum 10) __________

TOOL V WATER SOURCES, TYPE AND USE (Maximum 20)* __________

TOOL VI HUMAN USE (Maximum 20) __________

Total Score: __________

Comments:

Historic bighorn range:

* double the score for sections with water sources

Figure 2. Desert bighorn habitat evaluation data sheet.

was utilized for evaluating habitat factors that significantly affect desert bighorn. The method is based on environmental characteristics as well as degree of human use and consists of a series of components which, in combination, subjectively determine the suitability of an area as a possible release site. The various components or factors of the habitat were separated into categories and assigned appropriate titles (Table 1 and Appendix 1).

Table 1. Components used to determine suitability of an area as desert bighorn habitat.

Tool Number	Name	Points
I	Natural Topography	0 to 20
II	Vegetation Type	0 to 20
III	Precipitation	1 to 10
IV	Evaporation	1 to 10
V	Water, Type and Use	2 to 20
VI	Human Use	0 to 20

The analysis was done section by section. The maximum number of points normally available to each section of land was 100. Only lands within four miles (6.4 km) of a water source were given the value listed for this component. Sections between five and nine miles (8 to 14 km) from water received only 50 percent of that assigned to the nearest water source. Any section that was more than 10 miles (16 km) from the nearest water source received a value of zero for this component. Any section that had a water source within it received twice the total value as scored for this component. The values were assigned in such a way that human use, both actual and potential, would be favored in the less precipitous habitat and bighorn sheep would be favored in the areas that are vital to their existence. When there was a conflict of interest or the area was not very important to bighorn, the method indicated

the land as a buffer zone. Areas on which total scores were obtained were then classified according to size of score based on the classification system depicted by Table 2.

Table 2. Major classification of total scores for evaluating areas as potential desert bighorn sheep habitat.

Total Score	Classification
0 to 50	NOT IMPORTANT TO BIGHORN, OR OF HIGH VALUE FOR HUMAN USE: Sections that fell within this rating and have a score for Tool I of 8 or less are not important to bighorn sheep. Sections that have a score of 12 or more for Tool I may be in a Zone of Deficiency such as an inadequate water supply nearby.
51 to 64	BUFFER ZONE OR AREA OF POTENTIAL ECONOMIC VALUE OR OF MODERATE HUMAN USE: Sections that fell within this rating are ones which should be retained at least in their present status as a buffer against human encroachment. However, these areas may be improved upon for bighorn sheep in various ways through habitat manipulation or by a change in human use.
65 to 79	ZONE OF DEFICIENCY FOR BIGHORN OR AREA OF POTENTIAL ECONOMIC VALUE OR FOR OCCASIONAL HUMAN USE: Sections that fell within this category would be more valuable to bighorn sheep if some segment of the habitat were improved for them or if the economic potential or use were reduced or eliminated. Areas in this category should be critically examined before being removed from consideration.
80 to 100	IMPORTANT TO BIGHORN SHEEP: Sections in this category are important to bighorn. The importance may be due to items essential to the animals or because of the lack of human use or economic potential. Generally, sections in this category were in isolated, mountainous terrain.
100 and above	VITAL TO BIGHORN: Areas that are vital to bighorn are those that have some features without which the sheep cannot survive. The only areas that fall in this category are those that have water sources within them.

This system provided a rapid, qualitative evaluation of the relative suitability of each of the areas evaluated as desert bighorn habitat.

Base maps of each of the areas evaluated were constructed to facilitate data collection and interpretation of results. Topographic and planimetric maps were obtained and used to construct the base maps. The maps depict topography, major drainages, water sources, access, and manmade facilities. Overlays were then prepared portraying variables that characterize the habitat of the areas investigated. These variables include vegetation types, water sources, and habitat suitability.

Vegetation was analyzed by ocular reconnaissance of each of the study areas. The major plants occurring on the sites were identified and tabulated to facilitate description of the vegetative communities.

An effort was made to locate as many water sources as possible. Water sources were then classified as to type--spring, seep, earthen tank, or steel stock tank; status--permanent or rain dependent; and location in reference to physiographic features.

The final ranking of release sites for quantitative evaluation was subjectively determined based on the following criteria: 1) competition, existing or potential, 2) habitat availability, and 3) land status and use.

Description of Study Areas

Guadalupe Mountains

Study area. The Guadalupe Mountains are located in Eddy and Otero Counties, southeastern New Mexico (Figure 3). These mountains were formed during the Permian Era 225 to 280 million years ago. An inland sea which covered more than 10,000 square miles (25,900 sq km) of New Mexico and Texas

controlled their formation. It was in the shallow water near the shore of this sea that the barrier reef which composes the Guadalupe Mountains was deposited by lime-secreting algae and other organisms (Newell et al. 1953).

The mountain range resembles a giant wedge or "V", with El Capitan, a 2,000-foot (610-m) sheer cliff, at the apex in Texas. The northeast arm of the range represents the remains of the barrier reef, and terminates near Carlsbad, about 45 miles (72 km) northeast of El Capitan. The topography here is characterized by an abrupt escarpment which is bissected by numerous precipitous drainages, some which measure 2,000 feet (610 m) from rim to canyon bottom (Figure 4). The northwest arm of the range extends from El Capitan to the southeastern extension of the Sacramento Mountains, a distance of about 75 miles (121 km). The topography of the West Rim is relatively homogenous, lacking the extensive bissection typical of the east escarpment (Figure 5). The West Rim is characterized by a series of horizontally-layered limestone bedrock emplaced parallel to each other, giving a "stair-step" effect to the landscape.

Climate. The most representative weather records available for the study area are from Carlsbad Caverns National Park, situated along the northeast extension of the mountain range. Since vegetation in the two areas is similar, it is assumed that weather records from Carlsbad Caverns reflect the climate of the study area.

The climate of Carlsbad Caverns is of the arid continental type, characterized by low rainfall, warm summers, and mild winters. The average yearly precipitation is 14.8 inches (37.6 cm). August and September are the months of greatest precipitation with an average of 3.3 inches (8.5 cm). The least precipitation occurs in April (Figure 6). Sixty-eight percent of the precipitation falls as brief but occasionally heavy thundershowers. Snow falls a few

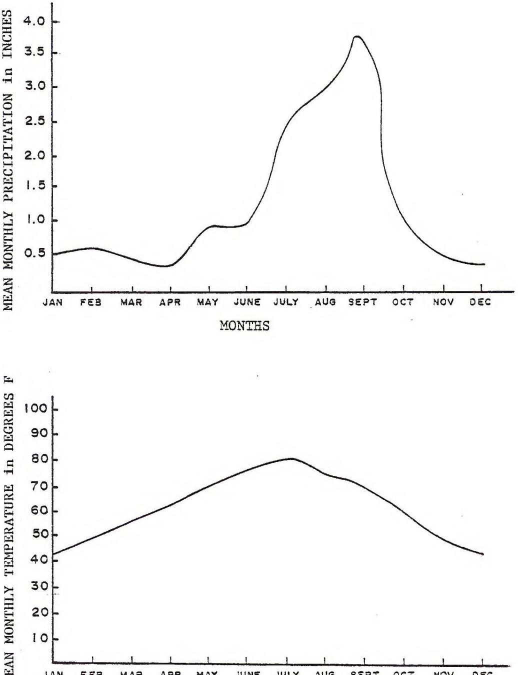


Figure 6. Mean monthly precipitation and temperatures for Carlsbad Caverns National Park, New Mexico, from 1966 to 1976.

times each winter but usually disappears within a day. Winds are light to moderate throughout most of the year, but may be strong during the spring. Humidities are low, probably averaging less than 25 percent (Maker *et al.* 1974). The mean annual temperature is 61.3 degrees F. (16.4° C.). January is the coldest month with an average temperature of 44.6 degrees F. (7.0° C.), and July is the warmest with an average temperature of 77.2 degrees F. (25.3° C.) (Figure 6).

Soils. Soils of the Guadalupe Mountains include the Calciorthids-Rockland-Paleorthids association (Maker *et al.* 1974). This association consists of gently to strongly sloping and undulating alluvial fans, piedmont slopes, and narrow valley bottoms intermingled with rolling to very steep limestone hills, tilted limestone ridges, and escarpments. The soils on the steep and mountainous landscape are dominantly shallow, cobbly, and stony and are forming in materials weathered from limestone.

Vegetation. Merriam's Life Zones represented in the Guadalupe Mountains include the Lower Sonoran, Upper Sonoran, and Transition. The Lower Sonoran is characterized by typical indicator species of the Chihuahuan Desert, such as sotol (*Dasylirion wheeleri*), agave (*Agave parryi*), lechuguilla (*Agave lechuguilla*), yucca (*Yucca torreyi* and *Y. elata*), and creosote bush (*Larrea tridentata*). The Upper Sonoran is best represented and more extensive, and is associated with gentler slopes, deeper soils, at higher elevations. This zone is dominated by piñon-juniper (*Pinus edulis*-*Juniperus monosperma* and *J. deppeana*) woodland, and mountain shrubs such as mountain mahogany (*Cercocarpus montanus*), oak (*Quercus* spp.), rhus (*Rhus trilobata*), and Texas madrone (*Arbutus texana*). The Transition Zone vegetation is typified by ponderosa pine (*Pinus ponderosa*), big tooth maple (*Acer grandidentatum*), scattered Douglas fir (*Pseudotsuga menziesi*), and limber pine (*Pinus flexilis*) (Figure

7 and Appendix 2).

Water availability. A total of 53 water sources were located in the Guadalupe Mountains (Figure 7 and Appendix 3). The majority of the naturally-occurring water sources are found within the major southeast drainages in close proximity to escape terrain. The accessibility to watering places would be satisfactory for bighorn and should adequately serve their needs.

Only one naturally-occurring water source (Devils Den Spring, NW¼ of the NE¼, S-21, T 26S, R 21E) was located along the 30 miles of the West Rim that were evaluated. This spring is located in a deep, timbered canyon. The few water sources along the West Rim of the mountain range are seasonal earthen stock tanks located in the foothills within Dog Canyon, and in the east-dipping slope of the summit which is characterized by piñon-juniper woodland.

History of bighorn occupancy. Vernon Bailey collected the type specimen of the bighorn indigenous to the Guadalupe Mountains in 1902 near the Texas-New Mexico border, and classified it as the Texas bighorn (Ovis canadensis texicana) (Bailey 1905). The principal morphological characteristics that Bailey utilized to distinguish texicana from mexicana were the narrower face, nasals and palate of texicana (Bailey 1905). Even though texicana and mexicana reveal variable characteristics, texicana apparently lacked sufficient differentiation to be deserving of subspecific rank. In his 1940 revision of American wild sheep, Cowan regarded them as one subspecies. Miller and Kellogg (1955) concurred with Cowan, relegating texicana as a synonym of mexicana. Bailey (1905) also found numerous sheep tracks and trails on the steep slopes of the West Rim, and reported sheep sign in the Brokeoff Mountains, west of the Guadalupe Range. About 300 bighorn were estimated to occupy the northeast arm of the Guadalupes in 1900 (Roberts 1938, cited by Snow and Zimmerman 1939) (Table 3). Aldo Leopold reported in 1919 that the

Guadalupe bighorn herd had sent out a branch herd into the Sacramento Mountains to the northeast (Gross 1960). However, Bailey (1928) disagreed, stating that the bighorn population was about static and that all reports from the Sacramento, Capitan, and Jicarilla Mountains indicated that no bighorn had been known in those ranges in modern times. The last confirmed report of bighorn in this vicinity was made in 1946 by L. W. Simmons of the New Mexico Department of Game and Fish. Simmons found an old ram which had been dead for about one year on the rim rocks of the Peñasco Canyon (Simmons 1946).

Table 3. Guadalupe Mountains bighorn sheep sightings and population estimates [Data from Gross (1960), and this study].

Date	Composition	Location	Source
1900	300	northeast arm of Guadalupe Mtns.	Manly Roberts
1914	100	general Guadalupe Mtns.	de Baca
1916	100	general Guadalupe Mtns.	J. S. Ligon
1928	100	general Guadalupe Mtns.	Vernon Bailey
1939	4	Texas Guadalupe Mtns.	Snow and Zimmerman
1939	4 hybrid lambs	Hughes Ranch (West Rim)	Snow
1940	1 dead ewe	McKittrick Canyon	Ben McCollum
1942	1	Helper Ranch (West Rim)	Woody Hughes
1942	1	Dog Canyon (West Rim)	Mrs. Sam Hughes
1943	0	general Guadalupe Mtns.	J. S. Ligon & O. Murie
1956	7	Smiths Canyon, Texas Guadalupe Mtns.	?
1956	20+	"a bit farther west"	?
1959	20+	Dark Canyon	Cliff Baumeister
1960	2 mature rams	Panama allotment, Guadalupe Mtns.	R. E. Rea
1976	1 unclassified	Dark Canyon	Hugh Kincaid
1976	1 ewe	West Rim	M. Hughes

In probing for the cause or causes responsible for the loss of the bighorn indigenous to the Guadalupe Mountains, we can speculate that competition

with domestic livestock, disease, and illegal harvest were major contributing factors. Since bighorn became scarce soon after domestic livestock ranching developed into a large-scale operation, it strongly suggests a direct cause-and-effect relationship. In the early 1930's, domestic livestock ranching developed into a large-scale operation in the Guadalupe Mountains. Snow and Zimmerman (1939) reported that domestic goats and sheep were utilizing the majority of the range once used by bighorn and that these domestic animals died annually in large numbers. Snow and Zimmerman (1939) also stated "In the Slaughter Canyon area on the east slope in New Mexico, goats have been stocked in such numbers that the range is practically ruined." Lang (1956) reported that similar conditions existed on the Texas side of the Guadalupe Mountains with several herds of over 1000 goats. Dr. F. W. Thacker, Carlsbad veterinarian, reported that over 50 percent of the goats in the Guadalupe Mountains were infected with Malta Fever (Brucella melitensis). Dr. Thacker also reported that the domestic goat and sheep were all infected with hemorrhagic septicemia (Pasteurella sp.), and the outbreaks occurred during drought periods when the water supply was restricted (Gross 1960). Ligon (1939) suggested that a direct relationship also existed between the rapid increase of domestic sheep-goat and deer-elk populations and the disappearance of bighorn in the Guadalupe Mountains. This undoubtedly must be considered as a contributing factor to the bighorn decline since there is little doubt that range overutilization was severe when the decline became apparent (Gross 1960).

Land status and use. Approximately 55 percent of the area evaluated in the Guadalupe Mountains is administered by the U.S. Forest Service, 28 percent is National Park Service lands (Carlsbad Caverns National Park), and 9 percent is administered by the Bureau of Land Management (Table 4).

Table 4. Land status in the Guadalupe Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
U.S. Forest Service	105	67,200	27,195	55
National Park Service	53	33,920	13,727	28
BLM	17	10,880	4,403	9
Patented Lands	9	5,760	2,331	5
State Lands	6	3,840	1,554	3
Totals	190	121,600	49,211	100

The Guadalupe Refuge of 23,000 acres (9,308 ha), and the Little Dog Refuge encompassing 25,000 acres (10,117 ha), were established by the State Game Commission for the protection of the bighorn; however, both were abolished in 1954 and 1956 respectively after evidence indicated that they had apparently not effected the desired population increase (Gross 1960).

The Guadalupe Mountains are divided into 11 grazing allotments. Records for the period 1939 through 1977 indicate an average of 1,311 sheep, 1,851 cattle, and 20 horses used the area on a yearlong basis. This represents a total of 43,215 animal unit months (Woltering 1978).

Results. A total of 121,600 acres (49,210 ha) were evaluated in the Guadalupe Mountains. Of this total, 50,560 acres (20,461 ha) were along the West Rim, from the New Mexico-Texas state line, northwest to the head of Little Dog Canyon. Twenty-eight percent of the West Rim was found to be suitable for bighorn sheep, while 11 percent was considered not important for bighorn. Twenty-four percent of the area was considered as marginal habitat, while 37 percent was classified as a buffer zone (conflict of interest or area is not very important to bighorn) (Table 5 and Figure 8).

Table 5. Evaluation of the Guadalupe Mountains as desert bighorn habitat.

Habitat Rating		Available Habitat							
		West Rim				Southeast Escarpment			
Points	Category	Sq Mi	Acres	Hectares	Percent	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	9	5,760	2,331	11	1	640	259	1
51 to 64	Buffer zone	29	18,560	7,511	37	8	5,120	2,072	7
65 to 79	Zone of deficiency (marginal habitat)	19	12,160	4,921	24	21	13,440	5,439	19
80 to 100	Impt. to bighorn (good habitat)	22	14,080	5,698	28	40	25,600	10,360	36
100+	Vital to bighorn* (optimum habitat)	-	-	-	-	41	26,240	10,619	37
	Totals	79	50,560	20,461	100	111	71,040	28,749	100

*54 percent, 5,698 hectares (14,080 ac) is within Carsbad Caverns National Park.

Sacramento Mountains

Study area. The study area included the west escarpment of the Sacramento Mountains southeast of Alamogordo in Otero County, from Fresnal Canyon, south to Grapevine Canyon in McGregor Range (Figure 9). The Sacramento Mountains rise in two steps above the Tularosa Basin. The crest near the west side of the tilted range reaches a maximum elevation of about 9,700 feet (2,957 m). East of the crest, the range slopes gradually eastward towards the Pecos Valley. The topography of the study area is characterized by an abrupt escarpment with steep-walled canyons forming vertical cliffs of sedimentary strata. Steep, highly-bisected alluvial fans descend from the cliffs to meet the Tularosa Basin (Figures 10 and 11).

Climate. The most representative weather records for the study area are from Alamogordo, situated about six miles (9.6 km) northwest.

The climate of Alamogordo is arid, characterized by low rainfall, warm summers, and mild winters. The average yearly precipitation is 12.18 inches (30.6 cm). July and August receive the greatest precipitation with an average of 2.42 inches (6.1 cm). April is the driest month with an average of .18 inches (.45 cm). Sixty percent of the annual precipitation falls between June and September (Figure 12). This precipitation occurs as brief but occasionally heavy showers. Snow falls each winter and accumulations of a foot (30.5 cm) or more can sometimes be found at higher elevations. The mean annual temperature is 61.1 degrees F. (16.3° C.). December is the coldest month with an average temperature of 42.4 degrees F. (5.9° C.), and July is the warmest month with an average temperature of 79.4 degrees F. (26.5° C.) (Figure 12).

Soils. Soils of the Sacramento Mountains include the Calciustolls-Rock Land association (Maker *et al.* 1974). The soils which are dominantly

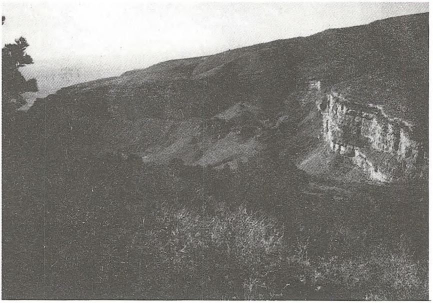


Figure 10. The topography of the West Escarpment in the Sacramento Mountains is characterized by steep walled canyons forming vertical cliffs of sedimentary strata.

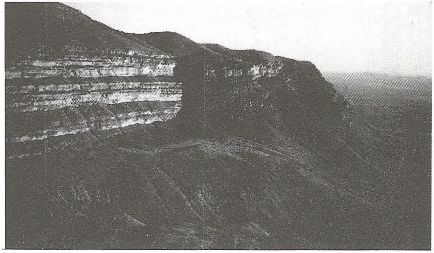
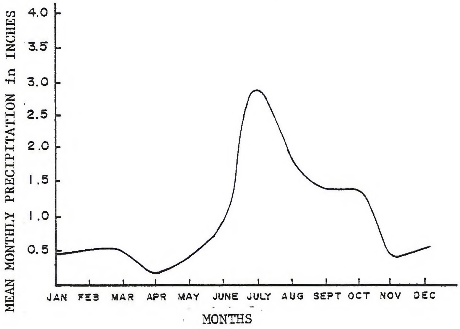


Figure 11. Steep alluvial fans descend from the cliffs to meet the Tularosa Basin along the West Escarpment of the Sacramentos.



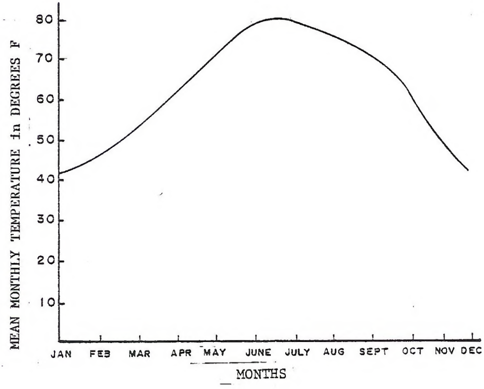


Figure 12. Mean monthly precipitation and temperatures for Alamogordo, New Mexico, from 1966 to 1976.

shallow, stony, and rocky, occur on strongly sloping and rolling to very steep uplands underlain by limestone. The limestone outcrops commonly occur as vertical or nearly vertical exposures and ledges.

Vegetation. Merriam's Life Zones represented in the study area include the Lower Sonoran, Upper Sonoran, and Transition. Exposed slopes at lower elevations are vegetated by a desert shrub/grass community intergrading into a mixed shrub type at higher elevations. A list of plants occurring in the Sacramento Mountains is presented in Appendix 4.

The desert shrub/grass community is dominated by mariola (Parthenium incanum), sotol, agave (Agave parryi), and bush muhly (Muhlenbergia porteri). The estimated vegetative cover was 35 percent. The estimated relative composition was 60 percent shrubs, 40 percent grasses, and 10 percent forbs. Bush muhly made up approximately 70 percent of the grassland type.

The mixed shrub type is dominated by mountain mahogany, algerita (Berberis trifoliolata), desert ceanothus (Ceanothus greggi), yucca (Yucca baccata), and sacahuista (Nolina microcarpa). Vegetative cover was estimated at 45 percent. The estimated relative composition was 75 percent shrubs, 20 percent grasses, and 5 percent forbs.

Protected slopes are vegetated by a dense oak (Quercus gambelii) shrub type at lower elevations and coniferous forest at higher elevations. The coniferous forest is dominated by ponderosa pine, Douglas fir, piñon pine, alligator bark juniper (Juniperus deppeana), and one-seed juniper (Juniperus monosperma). Canopy coverage in these communities approaches 100 percent (Figure 13).

Water availability. A total of 10 water sources were located along the West Escarpment (Appendix 5). Eighty percent of these consist of naturally-occurring springs and seeps located in deep, brush-covered canyons (Figure 13).

History of bighorn occupancy. Bailey (1931:18) wrote, "All the reports from the Sacramento, Capitan, and Jicarilla Mountains assert that no sheep have been known in these ranges in modern times." However, reliable reports of bighorn sightings in the Sacramento Mountains have been received since Bailey's statement (Table 6).

Table 6. Sacramento Mountains bighorn sheep sightings.

Date	Numbers	Location	Source
1936	16	Dog Canyon	Mr. Cadwalder
1940	2	Y-O Crossing	?
1942	4	Southern end-West Escarp	Cecil Kennedy and Santiago Valdez (U.S.F.W.S.)
1942	1 fresh ram skull	Mescalero Reservation	John Knox (U.S.F.W.S.)
1946	1 dead ram	Peñasco Canyon	L. W. Simmons (N.M.G.F.)

Land status and use. Approximately 59 percent of the area evaluated is administered by the U.S. Forest Service-Lincoln National Forest, 21 percent is within McGregor Range Military Reservation, 10 percent is BLM lands, and 9 percent is patented lands (Table 7).

Table 7. Land status in the Sacramento Mountains.

	Area			
	Sq Mi	Acres	Hectares	Percent
U.S. Forest Service	60	38,400	15,540	59
Military Reservation	21	13,440	5,439	21
BLM	10	6,400	2,590	10
Patented lands	9	5,760	2,331	9
State lands	1	640	259	1
Totals	101	64,640	26,159	100

The west side of the Sacramento Mountains is divided into five grazing allotments. An average of 4,621 animal unit months (AUM's) per year have been

allowed since 1957. The McGregor Range has been under grazing permit since 1967 and has received an average of 250 AUM's per year (Woltering 1978).

Outdoor recreation will be a major land use activity in the West Escarpment. The Oliver Lee Memorial State Park is to be constructed in Dog Canyon within the next two years. This park is part of a ten million dollar capital improvement program approved during the 1977 legislature. The park will offer such activities as camping with or without hookups, riding and hiking. The rock cabin of Jean Francois Rochas, a French mystery man, will be reconditioned.

Results. A total of 101 square miles (261 sq km) were qualitatively evaluated as potential habitat for desert bighorn in the Sacramento Mountains. Twenty-six percent of the area evaluated was classified as good habitat, 42 Percent as marginal habitat, and 29 percent as buffer zone (Table 8 and Figure 14). Ninety-two percent of the area classified as good habitat is within the Lincoln National Forest.

Table 8. Evaluation of the Sacramento Mountains as desert bighorn habitat.

Habitat Rating		Available Habitat			
Points	Category	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	2	1,280	518	2
51 to 64	Buffer zone	29	18,560	7,511	29
65 to 79	Zone of deficiency (marginal habitat)	43	27,520	11,137	42
80 to 100	Impt. to bighorn (good habitat)	26	16,640	6,734	26
100 +	Vital to bighorn (optimum habitat)	1	640	259	1
Totals		101	64,640	26,159	100

Caballo Mountains

Study area. The Caballo Mountains are located in Sierra County, 10 miles (16 km) southeast of Truth or Consequences, situated along the east side of the Rio Grande and Caballo Lake (Figure 15). The mountain range extends north-south for some 23 miles (37 km) and varies in width from two to seven miles (3.2 to 11 km).

The geologic structure of the Caballo Mountains is a tilted fault block with gentle east slopes and a precipitous west escarpment (Figure 16). The topography of the escarpment consists of a series of sedimentary bedrock outcrops descending in a "stair-step" arrangement to the Precambrian rocks which are exposed at the base (Figure 17).

The mountain range is divided into two parts by Palomas Gap (5,050 feet-1,539 m). The divide north of the Gap is called North Ridge and has one major summit, Caballo Cone (6,019 feet-1,835 m). South Ridge rises to 7,554 feet (2,302 m) at Timber Mountain, site of the Game and Fish Department's radio repeater.

Climate. The nearest weather recording station to the Caballo Mountains is at Caballo Dam, located along the western edge of the mountain range. These data are probably not indicative of climatic conditions at higher elevations. This theory is supported by plant distribution.

The average yearly precipitation for Caballo Dam is 9.23 inches (23.4 cm). July and August receive the greatest precipitation with an average of 2.13 inches (5.4 cm). April is the driest month with an average rainfall of .07 inches (.18 cm). Seventy-five percent of the annual precipitation falls between July and October (Figure 18). The mean annual temperature is 59.5 degrees F. (15.4° C.). January is the coldest month with an average temperature of 40.6 degrees F. (4.8° C.), and July is the warmest month with an

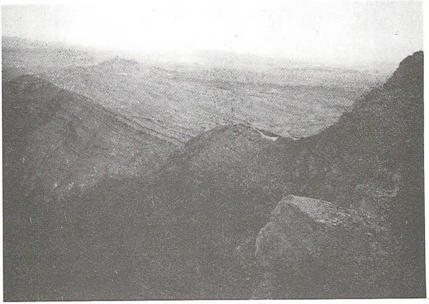


Figure 16. The geologic structure of the Caballo Mountains is a tilted fault block with gentle east slopes and a precipitous west escarpment.

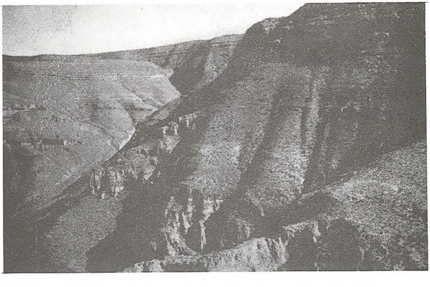
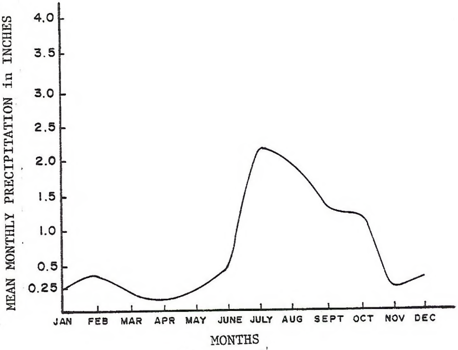


Figure 17. Topography along the west escarpment of the Caballo Mountains.



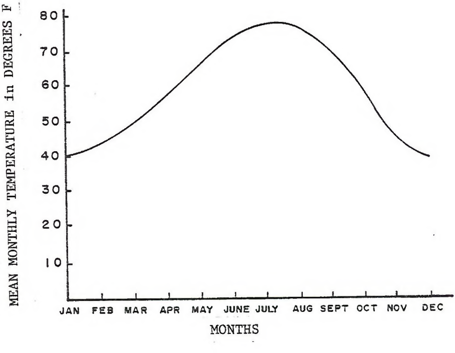


Figure 18. Mean monthly precipitation and temperatures for Caballo Dam, New Mexico, from 1966 to 1976.

average temperature of 80.1 degrees F. (27° C.) (Figure 18).

Soils. Soils of the Caballo Mountains are in the Rock Land-Lehmans-Lozier association. Rock Land is a complex of very shallow soils and rock outcrops. A thin mantle of cobbly or stony soil material commonly occurs between the outcrops of bedrock. The Lehman soils occur on the moderately steep and rolling to hilly landscape. These soils usually have a thin surface layer of brown stony loam over a reddish-brown, gravelly or stony clay subsoil. Lozier soils in this association have a thin surface layer of light brown calcareous, stony loam soil (Maker et al. 1972).

Vegetation. In general, east slopes are vegetated by piñon (Pinus edulis)-juniper (Juniperus monosperma) woodland at higher elevations, intergrading into a mixed shrub/grass type at lower elevations (Figures 19 and 20). The steep west exposures are vegetated by a desert shrub/grass type. Feeding areas are located on steep slopes situated between outcrops of bedrock (Figure 21). A list of plants occurring in the Caballo Mountains is presented in Appendix 6.

The desert shrub/grass type is dominated by mariola, sotol, cholla (Opuntia spinosior), Glossopetalon spinescens, sacahuista, needle grass (Stipa lettermani), muhly (Muhlenbergia spp.), and grama (Bouteloua spp.). The estimated vegetative cover was 30 percent. The relative composition was estimated at 60 percent shrubs, 30 percent grasses, and 10 percent forbs.

Piñon-juniper growth varies from scattered trees to densities approaching 100 percent. Understory consists mainly of mountain mahogany, oak shrub (Quercus turbinella) and prickly pear cactus (Opuntia engelmanni). Vegetative cover was estimated at 60 percent, with trees and shrubs accounting for about 90 percent relative composition, grasses comprising 8 percent, and forbs making up approximately 2 percent relative composition.

The mixed shrub type is composed of a heterogenous woody shrub association

Sutcliffe (1971) sampled the vegetation utilizing 270 line-point transects in 15 major canyons and found that the floristic composition consisted of 46.2 percent grasses, 45.3 percent shrubs, 8.1 percent trees and 0.37 percent forbs. The mean ground cover was 32.4 percent. Blue grama accounted for 40 percent of the total composition and broom snakeweed 17.2 percent. Oak (7.1 percent) and mountain mahogany (6.9 percent) were third and fourth in importance of composition.

Water availability. Sixteen water sources were located within or in close proximity to the Ladron Mountains (Figure 54 and Appendix 17). These include windmills, stock tanks, springs, seeps and water catchment units. The two water catchments were constructed specifically for wildlife and consist of a butyl rubber apron and a 5,000-gallon (1,321 l) storage tank. These catchments are reliable water sources and since construction have always contained water (BLM 1975). Five naturally-occurring springs were located. These include two which have been developed and provide a substantial yearlong water supply, one good spring which has been recently developed, one of limited flow with development potential and a small seasonal seep of questionable value. Water quality appeared to be good from all but the seep.

History of bighorn occupancy. The Ladron Mountains have apparently never been inhabited by bighorn sheep. One bighorn skull has reportedly been found in these mountains; however, it has not been positively identified as being that of a bighorn sheep (BLM 1975).

Land status and use. Fifty-six percent of the area evaluated in the Ladron Mountains is public domain, 28 percent is administered by the U.S. Fish and Wildlife Service, 9 percent is state lands, and 7 percent is patented lands (Table 16). The Sevilleta Grant encompasses 9,600 acres (3,885 ha) of the Ladron Mountains. The Grant was deeded to the U.S. Fish and Wildlife

Service by the Nature Conservancy for management as a wildlife refuge in 1973.

Table 16. Land status in the Ladron Mountains.

Ownership	Area Sq Mi	Acres	Hectares	Percent
Public domain	30	19,200	7,770	56
U.S. Fish and Wildlife Service	15	9,600	3,885	28
State lands	5	3,200	1,295	9
Patented lands	4	2,560	1,036	7
Totals	54	34,500	13,986	100

Ranching was begun in this area as early as 1880. In 1936, the area maintained 420 cattle, 51 horses, 1,400 sheep and 10 goats. Since this time, stocking rates have been reduced and at present the lower slopes are stocked with approximately 500 cattle and a few horses (BLM 1975). Six ranchers currently have grazing licenses on and around the mountain. Livestock use is primarily limited to the piedmont slopes.

Although the Ladron Mountain area has been intensively prospected, no commercially valuable lodes have been discovered. The mining endeavors have occurred mainly on the lower portions of the mountain.

Results. Fifty-four square miles (140 sq km) were qualitatively evaluated as potential desert bighorn habitat. Thirty-one percent of the area evaluated was classified as good habitat for bighorn, while 39 percent was considered as marginal habitat (zone of deficiency) (Table 17 and Figure 55).

Table 17. Evaluation of the Ladron Mountains as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Category	Points	Acres	Hectares	Sq Mi	Percent
Not impt. to bighorn	0 - 50	•	•	•	•
Buffer zone	51 - 64	8,960	3,626	14	26
Zone of deficiency (marginal habitat)	65 - 79	13,440	5,439	21	39
Impt. to bighorn (good habitat)	80 - 100	10,880	4,403	17	31
Vital to bighorn (optimum habitat)	100 plus	1,280	518	2	4
Totals		34,560	13,986	54	100

Florida Mountains

Study area. The Florida Mountains are located approximately 12 miles (20 km) southeast of Deming in southwestern New Mexico. This is a rugged, north-south trending range about 10 miles (16 km) long and 5 miles (8 km) wide (Figure 56). The geologic structure of the Florida Mountains is a homoclinal structure which dips easterly (Bavin 1975). The topography is characterized by large rock outcrops, high vertical cliffs, and numerous steep and narrow draws and canyons (Figure 57). The elevation of the study area ranges from approximately 4,600 feet (1,402 m) at the base, to the 7,448-foot (2,770 m) elevation of Florida Peak, for a total relief of about 2,800 feet (854 m).

Climate. Weather information was obtained for Deming (elevation, 4,301 feet-1,311 m). Average annual precipitation is 8.2 inches (20.8 cm). More than 50 percent of the annual precipitation occurs during the months of July, August and September. The greatest annual precipitation recorded was 20.4 inches (51.8 cm) in 1870. Since 1950, there have been seven years with total precipitation of less than 6 inches (15.2 cm) (Bavin 1975).

Average annual maximum temperature for Deming is 76 degrees F. (24.4° C.)

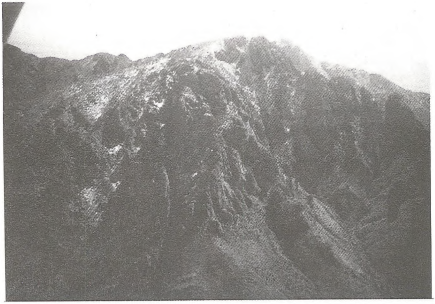


Figure 57. The topography of the Florida Mountains is characterized by large rock outcrops, high vertical cliffs, and numerous steep, narrow canyons.

and the average minimum temperature is 44 degrees F. (6.7° C.). The coldest recorded temperature is -12 degrees F. (-24.4° C.).

Soils. The soils in the Florida Mountains are classed in the Rock Land-Lehman soil association (Neher and Buchanan 1973). Extensive bare rock outcrops characterize the higher, steeper slopes. Rock varies from acid to basic igneous to limestone. Locally, stones and boulders dominate the surface. On the lower slopes, a mantle of gravelly loam to extremely rocky loam surface layer of soil has accumulated (Bavin 1975).

Vegetation. Merriam's Life Zones represented in the Florida Mountains include the Lower and Upper Sonoran. Exposed slopes are vegetated by an admixture of desert shrubs and grasses at lower elevations, intergrading into a mixed shrub/grass type at higher elevations, while protected slopes are vegetated by a mixed shrub/grass type. A piñon-juniper type is found growing on protected north-facing slopes at higher elevations, associated with shrub

oak and mountain mahogany (Figure 53).

The vegetation in the Florida Mountins was sampled utilizing 216 line transects 100 feet (30.5 m) long in 12 randomly-selected drainages (Wood et at. 1970). It was found that annual forbs represented the most abundant plant group on the east, south and west exposures. Forbs were the second most abundant group in the arroyo bottom samples and third on the north exposures. Shrubs such as mountain mahogany and Wright's silktassel (*Garrya wrightii*) occur in localized areas. Side oats grama and black grama were the most abundant grasses (Wood *et al.* 1970).

A list of plants occurring in the Florida Mountains is presented in Appendix 18.

Water availability. Thirty-three water sources are known to occur in or in close proximity to the Florida Mountains (Figure 58 and Appendix 19). These sources consist of springs, seeps, concrete dams, stock tanks, a water catchment unit and windmills. Numerous windmills supplying watering tanks for livestock are located in the major drainages near the mountain. There are numerous seeps and potholes throughout the range that provide water during all but the driest periods of the year (Bavin 1975). The New Mexico Department of Game and Fish constructed a water catchment unit on the east slope of the mountain range just below the summit (NE ¼ of the SW ¼, S-24, T-25, R-8W).

History of bighorn occupancy. Available records do not list the Florida Mountains as historic bighorn sheep range despite the fact that this range is sufficiently close to the West Potrillo Mountains so that bighorn seemingly could populate them with ease.

Land status and use. The Bureau of Land Management administers 20,302 acres (8,216 ha), which accounts for 72 percent of the area evaluated in the Florida Mountains. There are 3,936 acres (1,593 ha) of state-owned land and

an additional 1,020 acres (413 ha) that have a state withdrawal. Approximately 3,712 acres (1,502 ha) are privately owned (Bavin 1975). State withdrawal lands are administered by the Bureau of Land Management as if they were public lands.

Land use activities include grazing by domestic livestock, mining and recreation. Livestock grazing is under the control of the Bureau of Land Management. Approximately 275 cattle have grazed the area, year round, since 1940. From 1940 to 1946, an average of 1,023 goats grazed the mountain and in 1943, 600 sheep also grazed there. An average of 430 goats again grazed the area from 1953 to 1956 (Wood *et al*. 1970). At the present time, only cattle and horses graze the mountain and use of the range is considered light in most areas. There is almost no utilization by livestock of the steeper and more inaccessible areas.

One active mine is operational in the area. This fluorspar mine is located high on the mountain ridge, west of Gym Peak in the vicinity of the old Mahoney mines.

Rockhound State Park, located near the gap and at the base of the west side of the Little Florida Mountains, attracts tourists throughout the year. Located at the lower end of Spring Canyon within the Florida Mountains is a small picnic area that receives little use because of the rough access road.

Results. Forty-four square miles (114 sq km) were qualitatively evaluated as desert bighorn habitat. Thirty-seven percent of the area evaluated was classified as good habitat, 32 percent as marginal habitat and 27 percent as a buffer zone (Table 18 and Figure 59).

Table 18. Evaluation of the Florida Mountains as desert bighorn habitat.

Habitat Rating		Available Habitat			
Points	Category	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	0	0	0	0
51 to 64	Buffer zone	12	7,680	3,108	27
65 to 79	Zone of deficiency (marginal habitat)	14	8,960	3,626	32
80 to 100	Impt. to bighorn (good habitat)	16	10,240	4,144	37
100+	Vital to bighorn (optimum habitat)	2	1,280	518	4
Totals		44	28,160	11,396	100

West Potrillo Mountains

Study area. The West Potrillo Mountains (Spanish-colt) are located in western Dona Ana County approximately 40 miles (64 km) southwest of Las Cruces. By New Mexico standards, these mountains could more properly be termed the Potrillo Hills, as they consist of a series of low volcanic cinder cones stretching from the Mexican border to Interstate 10 (Figure 60). The West Potrillos reach an elevation of 5,501 feet (1,805 m), exhibiting a maximum relief of about 1,000 feet (328 m) from the surrounding desert. The topography is undulating and discontinuous (Figure 61).

Climate. The climate of the study area is of the arid continental type, characterized by low rainfall, hot summers and mild winters. Precise weather data for the West Potrillo Mountains are non-existent. The most representative recording station is University Park (elevation 3,881 feet-1,183 m), south of Las Cruces along the Rio Grande Valley.

The average yearly precipitation for University Park is 8.93 inches (22.7 cm). Fifty-nine percent of the precipitation falls between July and September. July receives the greatest amount with an average of 2.08 inches (5.28 cm). April is the driest month with an average of .13 inches (.33 cm)

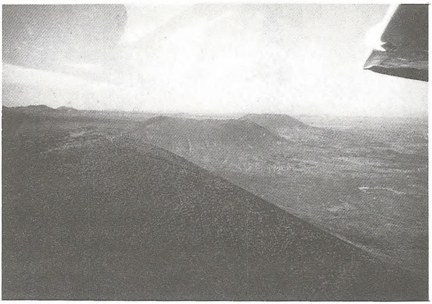


Figure 61. The topography of the West Potrillo Mountains is undulating and discontinuous, exhibiting a maximum relief of 1,000 feet (328 m).

(Figure 62). The mean annual temperature is 60.7 degrees F. (16.0° C.). December is the coldest month with an average temperature of 42.4 degrees F. (5.8° C.). July is the warmest month with an average temperature of 80.1 degrees F. (26.9° C.),(Figure 62). Evaporation from a Class A pan amounts to about 90 inches (228.6 cm). The frost-free season is 201 days.

Soils. The soils in the West Potrillo Mountains are classed in the Rock-Land-Torriorthents-Haplargids soil association (Maker et al. 1974). This association includes soils that are forming in materials of volcanic or basic igneous origin on old lava flows. Eolian sands, however, have been deposited over much of the basalt rock and are contributing significantly to the parent materials in which these soils are forming.

Lava Rock Land, a miscellaneous land type, occurs on fronts of lava flows, isolated basalt hills and areas dominated by rock outcrops and comprises 45

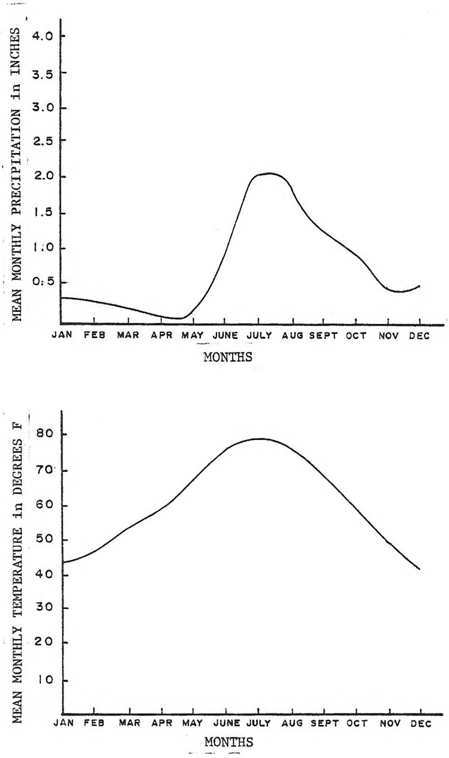


Figure 62. Mean monthly precipitation and temperatures for University Park, New Mexico, from 1966 to 1976.

percent of the association. It consists of a complex of shallow stony soils and outcrops of basalt bedrock. Torriorthents, developing where eolian sediments have contributed to the parent materials, comprise 20 percent of the association. They have surface layers of gravelly loam or very gravelly and cobbly sandy loam. The Haplargids occupy gently sloping and rolling landscapes amounting to about 15 percent of the association. They have a thin surface layer of brown stony loam (Maker *et al*. 1974).

Vegetation. The Lower Sonoran Life Zone typifies the majority of the mountain range. Extensive creosote/mesquite (*Larrea tridentata*/*Prosopis juliflora*) llanos characterize the lower elevations, while a desert shrub/grass type is found at higher elevations (Figures 63 and 64). Vegetative cover was estimated at 20 percent in the desert shrub community and the relative botanical composition at 85 percent shrubs, 10 percent grasses and less than 5 percent forbs. The desert shrub/grass community is characterized by typical indicator species of the Chihuahuan Desert such as ocotillo, soaptree yucca (*Yucca elata*), and cacti. Associated shrubs include snakeweed and scattered Mormon tea. The understory consists of black grama, tobosa (*Hilaria mutica*), fluffgrass (*Erioneuron pulchellum*) and three awn. Vegetative cover in this type was estimated at 30 percent and the relative composition at 70 percent shrubs, 25 percent grasses and 5 percent forbs.

A partial list of plants occurring in the West Potrillo Mountains is found in Appendix 20.

Water availability. Water sources in the West Potrillo Mountains are scarce. Free water was found to be non-existent within the mountain. A total of ten water sources were located adjacent to the study area (Figure 64 and Appendix 21). These sources are located from .5 to four miles (.8 to 6.4 km) from the mountain range and consist of windmills or earthen stock tanks that

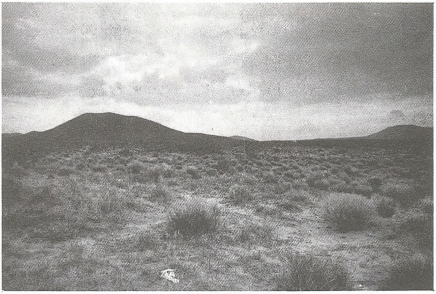


Figure 63. A desert shrub/grass community is found at higher elevations in the West Potrillo Mountains.

retain water seasonally. These sources are usually enclosed within a corral and receive frequent livestock use.

History of bighorn occupancy. In 1900, bighorn sheep were brought to a Deming meat market from the mountains 40 miles (64 km) southeast near the international boundary (Hornaday 1901, cited by Bailey 1931:21). Conceding that Hornaday's directions are correct, these sheep were taken from the West Potrillo Mountains. No other evidence (skulls, horns) of sheep has been found in this area.

Land status and use. Eighty-two percent of the land in the West Potrillo Mountains is administered by the Bureau of Land Management and 18 percent is state-owned (Table 19).

Table 19. Land status in the West Potrillo Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
BLM	109	69,760	28,231	82
State land	25	16,000	6,475	18
Totals	132	85,760	34,706	100

Livestock grazing, under the control of the Bureau of Land Management, is the major use of the West Potrillo Mountains. Other activities include off-road vehicle use and sightseeing. A series of volcanic cones, Aden, Hunt's and Kilbourne Holes, located just east of the West Potrillos, are tourist attractions.

Currently, the Bureau of Land Management is drafting procedures for inventorying and evaluating the West Potrillo Mountains for wilderness status. Under a law passed in 1976, the Bureau must evaluate the mountain range and define specific qualities that might make this area eligible for wilderness status. The Bureau has been given until 1991 to complete its survey and to submit recommendations to Congress (Gene Schloemer, BLM land specialist, pers. comm., August 3, 1978).

Results. A total of 134 square miles (347 sq km) were qualitatively evaluated as potential desert bighorn habitat in the West Potrillo Mountains. Fifty-five percent of the area evaluated was classified as not important for bighorn, while 45 percent was considered as a buffer zone (Table 20 and Figure 64-A).

Table 20. Evaluation of the West Potrillo Mountains as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Category	Points	Acres	Hectares	Sq Miles	Percent
Not impt. to bighorn	0 - 50	47,360	19,166	74	55
Buffer zone	51 - 64	38,400	15,540	60	45
Zone of deficiency (marginal habitat)	65 - 79	--	--	--	--
Impt. to bighorn (good habitat)	80 - 100	--	--	--	--
Vital to bighorn (optimum habitat)	100 plus	--	--	--	--
Totals		85,760	34,706	134	100

Cooke Range

Study area. Cooke Range, located 25 miles (40 km) north of Deming in Luna and Grant Counties, was named for Captain Philip St. George Cooke of the Mormon Battalion who passed through the area in the winter of 1846 (Sherman and Sherman 1975). In 1880, prospectors located the area's principle mines and established the townsite of Cooke, now a ghost town. A mill tailings pile and a couple of melted adobe ruins beside the tailings are the remnants of this once prosperous mining town.

Fort Cummings was built in 1863 at Cooke's Spring near the entrance to Cooke's Canyon, along the southeast side of the range. The fort stood near a stagecoach station of the Butterfield Overland Mail to protect mail carriers, emigrant trains and freighters (Pearce 1965). The fort was abandoned in 1891 and the only thing that remains today are the delapidated walls.

The Cooke Range extends north-south for some 20 miles (32 km) and averages about six miles (9.6 km) in width (Figure 65). Most of the mountain range is composed of faulted sedimentary bedrock (Figure 66); however, Cooke's Peak (elevation 8,404 feet-2,561 m) is an intrusive granite monolith (Figure 67).

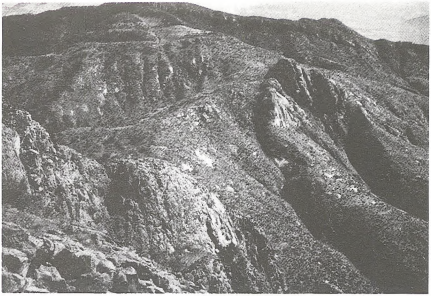


Figure 66. Most of Cooke's Range is composed of sedimentary bedrock.

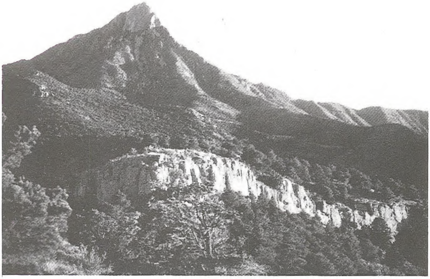


Figure 67. Cooke's Peak (8,404 feet-2,561 m) is an intrusive granite monolith.

Elevation varies from approximately 5,400 feet (1,646 m) along the piedmont to 8,404 feet (2,561 m) for a total relief of 3,000 feet (914 m).

Climate. Even though precise weather data for the Cooke Range are lacking, it can be assumed that climatic conditions are typical of the warm desertic region of New Mexico, characterized by an arid continental type with little rainfall, warm summers and mild winters.

The nearest recording station is located at Florida (elevation 4,450 feet-1,356 m), approximately 12 miles (19.2 km) southeast of the mountain range. The average yearly precipitation for Florida is 10.89 inches (27.6 cm). Fifty-six percent of the annual precipitation falls between July and September. August receives the greatest amount of precipitation with an average of 2.29 inches (5.8 cm). April is the driest month with an average of .06 inches (.15 cm) (Figure 68). The mean annual temperature is 58.9 degrees F. (15.1° C.). December is the coldest month with an average temperature of 39.9 degrees F. (4.4° C.). July is the warmest month with an average temperature of 78.5 degrees F. (26.0° C.) (Figure 68).

Soils. The soils in the Cooke Range are classed in the Rock Land-Haplargids soil association (Maker et al. 1974). These soils are mostly developing in material of igneous origin, however, limestone and other types of sedimentary rocks have contributed varying amounts to the parent materials.

Rock Land, a miscellaneous land type, constitutes about 60 percent of this association. It is a complex of very shallow soils and rock outcrops. The bedrock usually occurs as vertical or nearly vertical exposures and ledges, with a large amount of loose rock on the surface. A thin mantle of cobbly or stony soil material commonly occurs between the outcrops of bedrock. Although the intermingled soils are dominantly shallow, small areas of moderately deep soils occur as pockets among the rock outcrops and ledges. These small areas

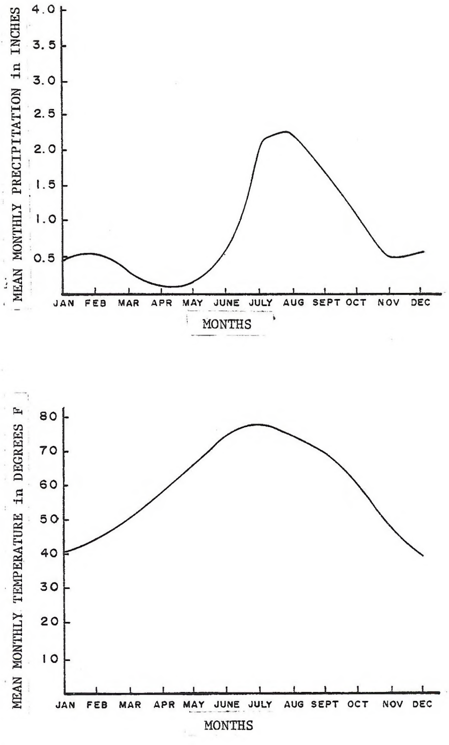


Figure 68. Mean monthly precipitation and temperatures for Florida, New Mexico, from 1966 to 1976.

of soil interspersed with the rock outcrops are highly variable; their characteristics are greatly influenced by the type of rock from which the parent materials are weathered.

The Haplargids, which constitute 40 percent of the area, commonly occur on moderately steep landscapes. These soils usually have thin, moderately coarse and medium-textured surface layers over finer-textured, moderately well-developed subsoils. Gravel, cobble and stones frequently occur in both surface and subsoil layers (Maker *et al.* 1974).

Vegetation. Merriam's Life Zones found in the Cooke Range include the Lower and Upper Sonoran. Much of the mountain is vegetated by a mixed shrub/mountain shrub type (Figure 69) and a mountain shrub/piñon-juniper woodland type at higher elevations (Figure 70). An open mixed shrub/grass community characterizes exposed slopes at lower elevations. Plants collected in Cooke's Range are listed in Appendix 22.

The mixed shrub/mountain shrub community is dominated by oak, rhus, cliff fendlerbush, pale leaf hoptree (*Ptelea pallida*), and mountain mahogany. Vegetative cover was estimated at 50 percent and the relative composition at 80 percent shrubs and trees, 15 percent grasses and 5 percent forbs. The mixed shrub/grass community consists of an overstory of mariola, ocotillo, snakeweed, algerita (*Berberis trifoliolata*), turpentine bush (*Aplopappus larcifolius*), and little leaf sumac (*Rhus microphylla*). The understory consists mainly of side oats grama, blue grama, and te de cota (*Thelesperma megapotimicum*). Vegetative cover in the mixed shrub/grass community was estimated at 30 percent and the composition at 60 percent shrubs/ 30 percent grasses and 10 percent forbs.

Arizona cypress (*Cupressus arizonica*) was found associated with piñon, alligator juniper, mountain mahogany, gray oak (*Quercus grisea*) and Emory oak

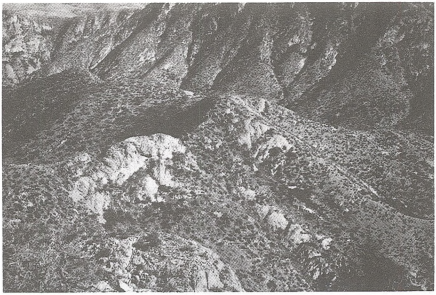


Figure 69. Much of the Cooke Range is vegetated by a mixed shrub/mountain shrub type.

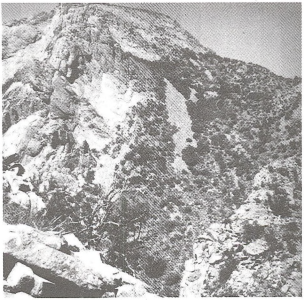


Figure 70. A mountain shrub/piñon-juniper type characterizes the higher elevations of Cooke's Range.

(Quercus emoryi) about two miles north of Cooke's Peak. This is the only Arizona cypress native to New Mexico, other than the San Luis Mountains in Hidalgo County. The cypress occur in four topographic features, and encompass an area of approximately 300 acres (121 ha); a. the gently sloping to rolling ridge top that forms the head of Hadley Canyon, b. the north-facing slopes of the ridge, c. the south-facing valley which forms Hadley Canyon, and d. narrow stringers of a few trees which follow the dry washes on both north and south sides of the ridge down to approximately 6,400 (1,951 m) (Figure 71).

Water availability. Water was found to be adequate in the Cooke Range. Thirty water sources were located within and adjacent to the mountain (Figure 71 and Appendix 23). Numerous natural seeps and springs were located high on the mountain within Provinger, Rattlesnake and OK Canyons. In addition, numerous windmills and steel stock tanks are found within the periphery of the range.

History of bighorn occupancy. Historical records do not mention the Cooke Range as ever being occupied by bighorn sheep. Bailey (1931:21) wrote, "In the country north of Deming there seems to be no recent records", of bighorn occupancy.

Land status and use. Fifty-two percent of the area evaluated in the Cooke Range is BLM land, 25 percent is patented land, and 20 percent is state land (Table 21).

Table 21. Land status in the Cooke Range.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
BLM	53	33,920	13,727	52
Patented land	26	16,640	6,734	25
State land	21	13,440	5,439	20
BLM administered lands	2	1,280	518	2
Totals	102	65,280	26,418	99

Human use consists of cattle grazing and mining activities. The eastern slope, from the desert plain to the summit of the mountain, is grazed on a year-long basis. The lower elevations are grazed during the warm season, while the interior or higher elevations are grazed from about November to March (Jim Hyatt, local rancher, pers. comm., September 22, 1977). Mr. Tom Miller runs approximately 300 head of cattle on 36 sections of leased land in the plains west of the mountain range (Tom Miller, local rancher, pers. comm., September 21, 1977). The Hyatts also operate a sizeable spread along the west slope of the mountain.

Thirty-eight abandoned mines and prospects were located in Hadley Canyon and north of Montezuma Canyon, along the west slope. The silver depression in 1893 suspended much of the mining activity in the area (Sherman and Sherman 1975); however, the possibility exists of re-opening some of these mines (Tom Miller, local rancher, pers. comm., September 21, 1977). The Silver Eagle Mines located in the extreme north end of the range is currently in operation. Access to this mine is a rough road from Faywood (Dwyer), on State Road 61 (Figure 65).

Results. A total of 65,280 acres (26,418 ha) were qualitatively evaluated in the Cook Range as potential desert bighorn habitat. Forty-seven percent of the area evaluated was classified as a buffer zone, 30 percent as

not important to bighorn sheep, and 13 percent as marginal habitat (Table 22 and Figure 72).

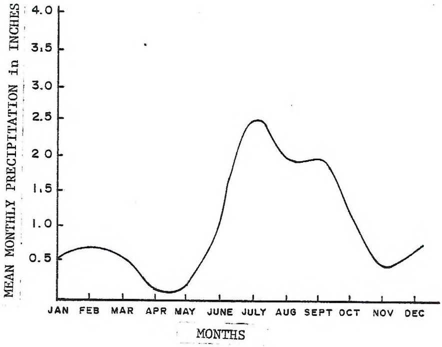
Table 22. Evaluation of the Cooke Range as Desert bighorn habitat.

Habitat Rating		Available Habitat			
Points	Score	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	31	19,840	8,029	30
51 to 64	Buffer zone	48	30,720	12,432	47
65 to 79	Zone of deficiency (marginal habitat)	13	8,320	3,367	13
80 to 100	Impt. to bighorn (good habitat)	10	6,400	2,590	10
100+	Vital to bighorn (optimum habitat)	-	-	-	-
Totals		102	65,280	26,418	100

Burro Mountains-Gila Middle Box

Study area. The study area included the Middle Box of the Gila River, from Red Rock north to the junction of Schoolhouse Canyon with the Gila River, and the Big Burro Mountains on the west side adjacent to the Middle Box (Figure 73). The topography is characterized by narrow valley floors and upland summits frequently separated by steep canyon walls, escarpments, and steep-sided slopes. Elevation varies from 4,320 feet (1,317 m) along the Gila River to 6,855 feet (2,089 m) at High Peak, giving a maximum relief of 2,535 feet (832 m).

Climate. Annual precipitation and temperature patterns for Red Rock (elevation 4,150 feet-1,265 m) are generally representative of the study area. The average annual precipitation for Red Rock is 12.35 inches (31.4 cm). Seventy-two percent of the annual precipitation falls between June and October as brief but sometimes intense thundershowers. July receives the greatest amount of precipitation with an average of 2.54 inches (6.5 cm). April is the driest month with an average of .10 inches (.25 cm) (Figure 74). Lower



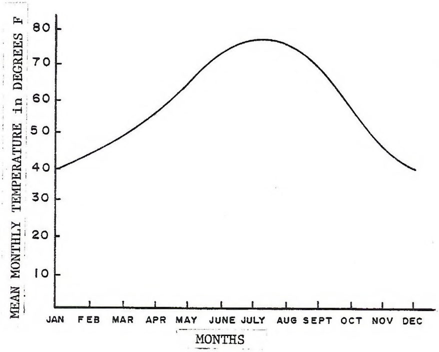


Figure 74. Mean monthly precipitation and temperatures for Red Rock, New Mexico, from 1966 to 1976.

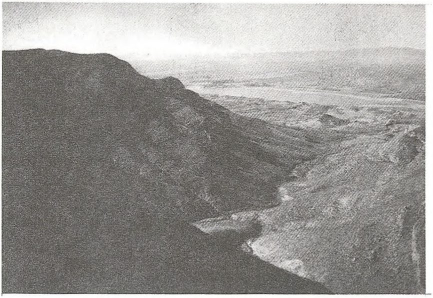


Figure 20. Piñon-juniper woodland occurs at higher elevations intergrading into a mixed shrub/grass community at lower elevations, in the Caballo Mountains.

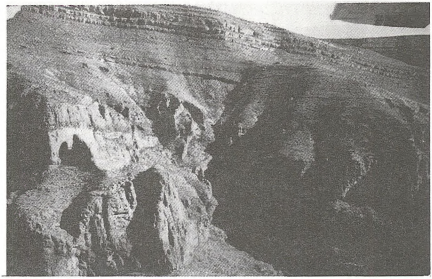


Figure 21. West exposures of the Caballos are vegetated by a desert shrub/grass type. Feeding areas are situated between outcrops of bedrock.

forming the dominant overstory with a few perennial grasses forming the understory. The most conspicuous species include sacahuista, snakeweed (*Gutierrezia* spp.), yucca, rhus (*Rhus trilobata* and *R. microphylla*), and white thorn (*Acacia constricta*). Vegetative cover was estimated at 40 percent, and the relative botanical composition at 75 percent shrubs, 20 percent grasses, and 5 percent forbs.

Water availability. Naturally-occurring water was found to be nonexistent within the Caballo Mountains. Only four springs were located, all in the alluvium along the west side. The remaining sources are manmade, and include nine earthen stock tanks that hold water seasonally, two windmills with permanent water, and a rain catchment unit that appears to hold water year round (Figure 19 and Appendix 7). Caballo Lake and the Rio Grande are situated about three miles (4.8 km) west of the mountain range.

History of bighorn occupancy. The only known report of bighorn sightings in the Caballo Mountains is from Fred Weir of Silver City. He related that a cowboy from the John Cross ranch (which was located within the present site of the town of Truth or Consequences) saw a bighorn sheep in the Caballo range in 1907. An employee of the ranch who was present when the original story was told, hearing of this report, brought the skull and horns of a mature ram, which had been found in the Caballo Mountains, to the cowboy (San Andres Refuge files).

Land status and use. Approximately 85 percent of the area evaluated in the Caballo Mountains is public land administered by the Bureau of Land Management, eight percent is state lands, and six percent is patented lands (Table 9).

Table 9. Land status in the Caballo Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
BLM	70	44,800	18,130	85
State lands	7	4,480	1,813	8
Patented lands	5	3,200	1,295	6
Water projects withdrawal		80	32	.15
Powersite withdrawal		40	16	.08
Totals	82	52,480	21,238	99.23

Livestock grazing and mining are associated land uses in the Caballo Mountains. Access to many parts by livestock is limited by steep slopes and roughness of the land surface. This tends to restrict grazing to alluvial fans where overutilization of the limited forage was evident and further attested by the presence of invader species such as snakeweed and numerous annual forbs. Two operational mines are located in the alluvium at the base of the west escarpment and a third is located on the summit of Brushy Mountain (7,300 feet-2,225 m).

A gravel road has recently been completed to the summit of Timber Mountain (7,554 feet-2,302 m), where the New Mexico Department of Radio Communications maintains a series of microwave repeaters and radio towers. A rough road follows the entire summit of South Ridge and descends southeast into the Jornada del Muerto Plains.

Results. A total of 52,480 acres (21,238 ha) were evaluated in the Caballo Mountains. Sixty percent of the area evaluated was considered as a buffer zone (conflict of interest) and area not very important to bighorn. Thirty-five percent was considered as marginal habitat and five percent was considered as important to bighorn sheep (good habitat) (Table 10 and Figure 22).

Table 10. Evaluation of the Caballo Mountains as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Category	Points	Acres	Hectares	Square Miles	Percent
Not important to bighorn	0- 50	5,120	2,072	8	10
Buffer zone	51- 64	26,240	10,619	41	50
Zone of deficiency	65- 79	18,560	7,511	29	35
Important to bighorn	80-100	2,560	1,036	4	5
Vital to bighorn	100+	0	0	0	0
Totals		52,480	21,238	82	100

Fra Cristobal Range

Study area. The Fra Cristobal Range is located in Sierra and Socorro Counties, 15 miles (24 km) northeast of Truth or Consequences. The mountain range is relatively narrow (three to five miles-five to eight km) wide and extends for some 20 miles (32 km) along the east side of Elephant Butte Reservoir (Figure 23). Together with the Caballo Mountains to the south, this range forms an almost continuous bare mountain chain on the east side of the Rio Grande between Hatch and San Marcial, just south of Socorro. The Fra Cristobal Range can be considered as two separate geographic units, consisting of faulted limestone bedrock separated by a series of outcrops of red sandstone and shale. Structurally, the mountain range is a west-facing fault block, with numerous precipitous escarpments (Figure 24).

The topography along the west escarp is characterized by horizontally-layered limestone cliffs, varying in height from 2 to 30 feet (.6 to 9 m), thus giving a "stair-step" effect to the landscape (Figure 25). The east-dipping slope is deeply bisected by numerous small drainages. The topography here consists of undulating hills frequently broken by deep, narrow canyons that average about 500 feet (152 m) in depth.

Climate. Weather records from Truth or Consequences were assumed to be

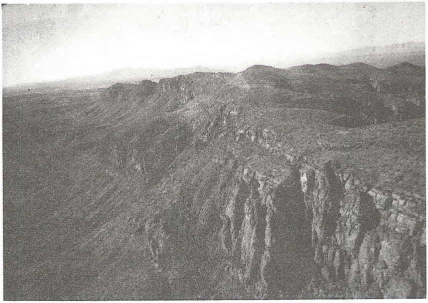


Figure 24. Vertical outcrops of bedrock characterize much of the Fra Cristobal Mountains.

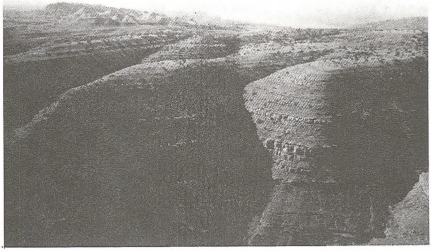


Figure 25. Horizontally-layered limestone bedrock on the west escarpment of the Fra Cristobal range.

fairly representative of the Fra Cristobal Mountains, and were thus used to approximate seasonal rainfall distribution and temperature trends.

The average yearly precipitation for Truth or Consequences is 10.89 inches (27.7 cm). Sixty-eight percent of the precipitation falls between July and October. September receives the greatest amount of precipitation with an average of 2.16 inches (5.5 cm). April is the driest month with an average of .06 inches (.15 cm) (Figure 26). The mean annual temperature is 58.9 degrees F. (15° C.). December is the coldest month with an average temperature of 39.8 degrees F. (44° C.), and July is the warmest month with an average temperature of 78.4 degrees F. (26° C.) (Figure 26).

Soils. Soils of the Fra Cristobal Mountains include the Rock Land-Lehman-Lozier association. Rock Land is a major component of this association, and consists of a complex of very shallow soils and rock outcrops. In many parts, a large amount of loose rock occurs on the surface. The Lehmans soils occur on the moderately steep and rolling to hilly landscape. They consist of brown stony loam over reddish-brown, gravelly or stony clay subsoil. They are typically underlain by igneous bedrock within 20 inches (50.8 cm) of the surface. Lozier soils are extensive on the moderately steep surface layer of calcareous stony loam soil (Maker et al. 1972).

Vegetation. The Fra Cristobal Range reaches a maximum elevation of 6,800 feet (2,072 m), and lies primarily in the Lower Sonoran Life Zone. Between 5,000 and 6,000 feet (1,524-1,829 m), east-facing slopes are vegetated by a desert shrub/grass community (Figure 27). A savannah type, characterized by scattered piñon and juniper, with a good undergrowth of grasses, occurs above 6,000 feet (1,829 m). About 75 percent of the juniper and piñon trees growing on exposed slopes were decadent, imparting a depressing grayish cast to the overstory. This might suggest recent prolonged drought as these

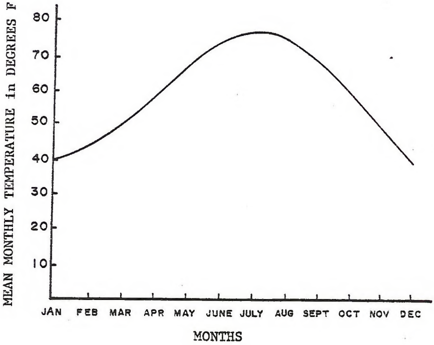


Figure 26. Mean monthly precipitation for Truth or Consequences, New Mexico, from 1966 to 1976.

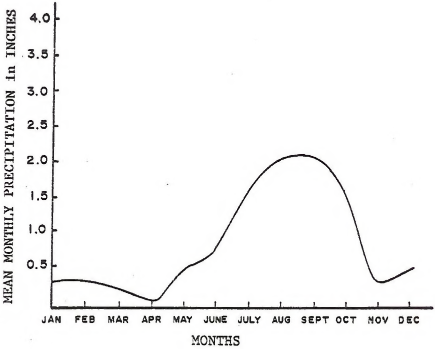


Figure 26-A. Mean monthly temperatures for Truth or Consequences, New Mexico, from 1966 to 1976.

trees exhibited vigorous growth on protected slopes and along dry drainage bottoms. The steep, west-facing slopes are vegetated by a desert shrub/grass type on exposed aspects and by a mixed shrub/grass type on protected aspects. Plants identified in the Fra Cristobal Mountains are listed in Appendix 8.

The desert shrub/grass community is dominated by mariola, prickly pear cactus, ocotillo, and black grama (*Bouteloua eripoda*) (Figure 28). Vegetative cover was estimated at 20 percent, with trees and shrubs accounting for 60 percent relative composition, grasses 30 percent and forbs 10 percent composition.

Mountain mahogany, algerita, rhus, snakeweed, black grama and three awn (*Aristida* spp.) characterize the mixed shrub/grass community. Vegetative cover was estimated at 30 percent, and the relative botanical composition at 75 percent shrubs, 20 percent grasses, and 5 percent forbs.

The undulating topography on the summit of the northern geographic unit of the Fra Cristobal Range is characterized by an open piñon-juniper type with a dense understory of grasses (Figure 29). This type is dominated by muhly (*Muhlenbergia* spp.), needle grass (*Stipa* spp.), side oats and blue grama, scattered piñon, juniper, algerita, and yucca. Vegetative cover was estimated at 40 percent, and the relative composition at 70 percent grasses, 20 percent trees and shrubs, and 10 percent forbs.

Water availability. Five naturally-occurring water sources were located in the Fra Cristobal Mountains. All five are found within one square mile (2.6 sq km) (Figure 27 and Appendix 9). In addition, these sources are located in relative gentle topography approximately three to four miles (4.5 to 6.4 km) from what appears to be the most suitable habitat for desert bighorn. Three earthen stock tanks were found within the mountain, however only

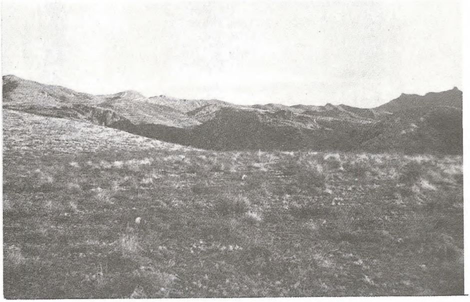


Figure 28. A desert shrub/grass community on the east-facing slopes of the Fra Cristobal Mountains.

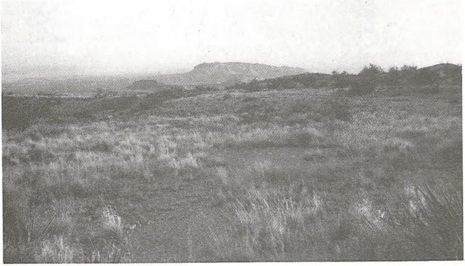


Figure 29. An open piñon-juniper type with a good understory of grasses characterizes the summit of the Fra Cristobal range.

two appear to hold water seasonally. Elephant Butte Lake is located four to six miles (6.4 to 9.6 km) west of the mountain range. Bighorn would have to traverse this span of non-representative sheep habitat to water.

Land status and use. The Fra Cristobal Mountains lie within the Pedro Armendariz Land Grant Number 33. The original owner of this grant was a lieutenant in the Santa Fe garrison in 1808 and received the land grant in 1820. He was forced to abandon it because of Indian attacks and left New Mexico for Chihuahua in 1822 (Pearce et al. 1965). Since then, the grant has changed ownership numerous times. The current owner is the German National Corporation.

The subdued topography and extensive grassland types found along the summit make the Fra Cristobals especially attractive for livestock grazing. Grazing, however, is localized around water sources.

Results. A total of 39,040 acres (15,799 ha) were evaluated in the Fra Cristobal Range. Thirty-two percent of the area evaluated was classified as good habitat, 30 percent as marginal, and 28 percent as buffer zone (Table 11). Ten percent was classified as not important to bighorn (Table 11 and Figure 30).

Table 11. Evaluation of the Fra Cristobal Range as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Category	Points	Acres	Hectares	Square Miles	Percent
Not important to bighorn	0 to 50	3,840	1,554	6	10
Buffer zone	51 to 64	10,880	4,403	17	28
Zone of deficiency	65 to 79	11,520	4,664	18	30
Important to bighorn	80 to 100	12,800	5,180	20	32
Vital to bighorn	100+	0	0	0	0
Totals		39,040	15,799	61	100

San Mateo Mountains

Study area. The San Mateo Mountains are located between the Magdalena Mountains and the Black Range in Socorro County. They extend about 46 miles (74 km), from the Plains of San Agustin to the Rio Grande Valley west of Elephant Butte Reservoir (Figure 31).

The study area was located within the Cibola National Forest, and included a U-shaped area situated along the southeast, south, and southwest portions of the mountain range. The elevation of the study area extended from the mixed shrub/grass type of the potential sheep habitat at approximately 6,000 feet (1,829 m) to the summit of Vicks Peak (10,270 feet-3,369 m) and San Mateo Mountain (10,145 feet-3,328 m) (Figure 32).

The mountain range consists of Tertiary volcanic rocks which rise some 4,000 feet (1,219 m) above the surrounding plains. The topography is characterized by massive vertical cliffs, with large areas of rock and talus slopes situated between rugged rock outcrops and cliffs (Figure 33).

Climate. Weather reports for the San Mateo Mountains do not exist. The most representative reporting station is the Kingston Ranger Station situated along the east side of the Black Range at an elevation of 6,040 feet (1,841 m). Since vegetation in the two areas is similar, it is assumed that weather data from Kingston reflects the climate of the study area.

The average annual precipitation for Kingston is 17.34 inches (44.0 cm). Seventy percent of the precipitation falls between July and October. The mean maximum temperature is 70 degrees F. (21.3° C.), and the mean minimum temperature is 39 degrees F. (3.9° C.).

Soils. Soils of the San Mateo Mountains include the Haplustolls-Arguistolls-Rock Land association. This association consists of hilly to very steep mountainous landscape. The soils are generally gravelly or stony and

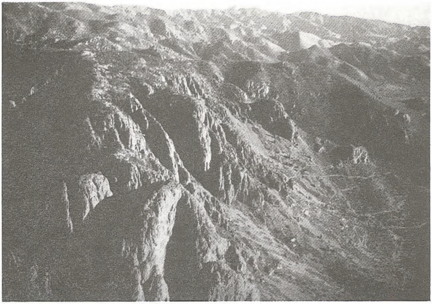


Figure 32. Aerial view of the study area, in the southern portion of the San Mateo Mountains.

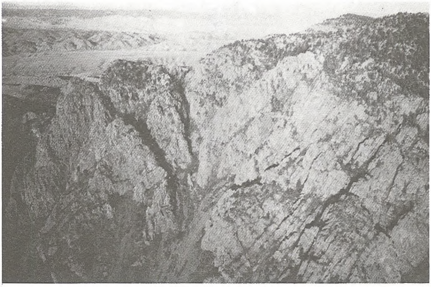


Figure 33. The topography in the San Mateo Mountains consists of massive vertical cliffs, with large areas of talus situated between rock outcrops.

shallow and are forming in parent materials weathered mainly from conglomerates and mixed igneous rocks. Rock outcrops and talus are common along very steep side slopes below ridge tops (Figure 34). Although the content of gravel and stones is highly variable, most soils in this association have gravelly and stony surface layers (Maker *et al.* 1972).

Vegetation. Merriam's Life Zones represented in the San Mateo Mountains include the Upper Sonoran, Transition, and the Hudsonian. The mountain range is vegetated by extensive stands of mixed coniferous forest (Douglas fir-*Pseudotsuga menziesi*, white fir-*Abies concolor*, limber pine-*Pinus flexilis*, and Engelman spruce-*Picea engelmanni*) on protected slopes (Figure 35). Canopy coverage approaches 100 percent in this community. The dense tree canopy admits little light to the understory which is practically void of herbage vegetation. Grasses and forbs were estimated to account for less than five percent relative composition.

Exposed slopes are vegetated by mountain shrub species such as mountain mahogany, cliff fendler bush (*Fendlera rupicola*), Gambel's oak (*Quercus gambelii*), and rockspirea (*Holodiscus dumosus*). The mountain shrub community exhibits a dense understory that severely restricts visibility and makes walking difficult. Vegetative cover was estimated at 70 percent, and the relative floristic composition at 80 percent shrubs, 15 percent grasses, and less than 5 percent forbs.

Extensive grassland types (*Muhlenbergia* spp., *Bouteloua* spp., and *Agropyron* spp.) characterize the piedmont. Most of this type has the visual aspect of a homogenous grassland community with scattered piñon, juniper, algerita, and mountain mahogany, situated in a series of benches along the exposed south-facing slopes at lower elevations. The total vegetative cover was estimated at 40 percent and the floristic composition at 70 percent

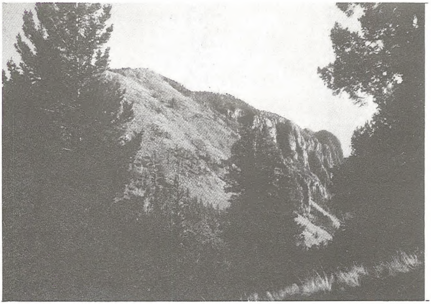


Figure 34. Rock outcrops and talus are common along very steep side slopes below ridge tops. Vicks Peak (10,145 feet-3,328 m) is on the left.

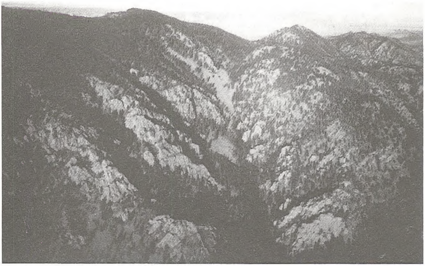


Figure 35. The San Mateo Mountains are vegetated by extensive stands of coniferous stands on protected slopes.

Sutcliffe (1971) sampled the vegetation utilizing 270 line-point transects in 15 major canyons and found that the floristic composition consisted of 46.2 percent grasses, 45.3 percent shrubs, 8.1 percent trees and 0.37 percent forbs. The mean ground cover was 32.4 percent. Blue grama accounted for 40 percent of the total composition and broom snakeweed 17.2 percent. Oak (7.1 percent) and mountain mahogany (6.9 percent) were third and fourth in importance of composition.

Water availability. Sixteen water sources were located within or in close proximity to the Ladron Mountains (Figure 54 and Appendix 17). These include windmills, stock tanks, springs, seeps and water catchment units. The two water catchments were constructed specifically for wildlife and consist of a butyl rubber apron and a 5,000-gallon (1,321 l) storage tank. These catchments are reliable water sources and since construction have always contained water (BLM 1975). Five naturally-occurring springs were located. These include two which have been developed and provide a substantial yearlong water supply, one good spring which has been recently developed, one of limited flow with development potential and a small seasonal seep of questionable value. Water quality appeared to be good from all but the seep.

History of bighorn occupancy. The Ladron Mountains have apparently never been inhabited by bighorn sheep. One bighorn skull has reportedly been found in these mountains; however, it has not been positively identified as being that of a bighorn sheep (BLM 1975).

Land status and use. Fifty-six percent of the area evaluated in the Ladron Mountains is BLM land, 28 percent is administered by the U.S. Fish and Wildlife Service, 9 percent is state lands, and 7 percent is patented lands (Table 16). The Sevilleta Grant encompasses 9,600 acres (3,885 ha) of the Ladron Mountains. The Grant was deeded to the U.S. Fish and Wildlife Service

by the Nature Conservancy for management as a wildlife refuge in 1973.

Table 16. Land status in the Ladron Mountains.

	Area			
Ownership	Sq Mi	Acres	Hectares	Percent
BLM	30	19,200	7,770	56
U.S. Fish and Wildlife Service	15	9,600	3,885	28
State lands	5	3,200	1,295	9
Patented lands	4	2,560	1,036	7
Totals	56	34,500	13,986	100

Ranching was begun in this area as early as 1880. In 1936, the area maintained 420 cattle, 51 horses, 1,400 sheep and 10 goats. Since this time, stocking rates have been reduced and at present the lower slopes are stocked with approximately 500 cattle and a few horses (BLM 1975). Six ranchers currently have grazing licenses on and around the mountain. Livestock use is primarily limited to the piedmont slopes.

Although the Ladron Mountain area has been intensively prospected, no commercially valuable lodes have been discovered. The mining endeavors have occurred mainly on the lower portions of the mountain.

Results. Fifty-four square miles (140 sq km) were qualitatively evaluated as potential desert bighorn habitat. Thirty-one percent of the area evaluated was classified as good habitat for bighorn, while 39 percent was considered as marginal habitat (zone of deficiency) (Table 17 and Figure 55).

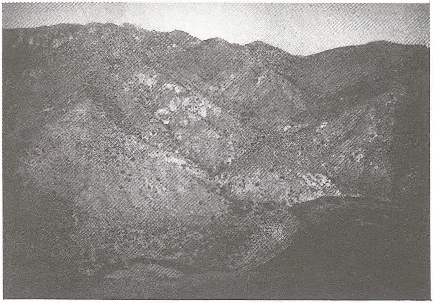


Figure 75. Riparian vegetation borders steep slopes which rise approximately 800 to 1000 feet (244 to 305 m) to a mixed shrub/grassland community.

elevations average from one to four inches of snow a season, higher elevations a foot or more. In the lower elevations, snow seldom remains long on the ground. The mean annual temperature is 58.6 degrees F. (14.9° C.). December is the coldest month with an average temperature of 40.6 degrees F. (4.8° C.). July is the warmest month with a mean temperature of 78.7 degrees F. (26.1° C.) (Figure 74).

Soils. The soil of the study area is classified as Rock Land-Luzena-Santana association (Maker et al. 1971). The soils are basically of two parent materials. The western portion is granite and metamorphic rock of Precambrian age, known as Burro Mountains granite. The eastern portion, adjacent to the Gila River, is a conglomeratic terrain of late Tertiary and early Quaternary age referred to as Gila conglomerate (Maker et al. 1971). Although the content of gravel and stones is highly variable, most soils in the Gila conglomerate association have strong or gravelly surface layers.

Vegetation. The Lower and Upper Sonoran Life Zones characterize the study area. Vegetation is highly varied due to soils derived from different parent materials, elevation, and exposure. Exposed slopes are vegetated by a desert shrub/grass community intergrading into a mixed shrub/grass type at higher elevations. Protected slopes are vegetated by a mixed shrub community at lower elevations, and a mixed shrub/pine-oak woodland at higher elevations. A partial list of plants occurring in the Burro Mountains-Gila Middle Box is presented in Appendix 24.

Riparian vegetation is contiguous to the Gila River and associated with arroyos and the drainage complex along the west side of the river. Riparian vegetation is composed primarily of Fremont cottonwood (*Populus fremonti*) in more favorable areas, catclaw acacia (*Acacia greggi*), mesquite, and various annual forbs. The riparian vegetation along the river borders steep slopes which rise approximately 800 to 1000 feet (244 to 305 m) to a mixed shrub/grassland type (Figure 75). This community consists of catclaw acacia, whitethorn (*Acacia constricta*), galleta (*Hilaria jamesii*), black grama, and threeawn. A mixed shrub type, consisting of shrub live oak, turpentine-bush, Apache plume (*Fallugia paradoxa*), and mountain mahogany, is found situated above the mixed shrub/grass community. Protected slopes are characterized by a juniper-shrub type consisting of one-seed juniper (*Juniperus monosperma*), shrub live oak, snakeweed, black grama, and various forbs. A few ponderosa pine are found in the northwestern portion of the study area, on north slopes and at higher elevations.

De Lorenzo (1974) sampled the vegetation at the Red Rock bighorn sheep enclosure utilizing 60 100-foot (30.5 m) line-point transects and modified belt transects to determine vegetative cover, composition, and density. The following data are for 1972 and 1973, respectively. Ground cover for the

Figure 76. The Gila River flows through the study area in a general northeast to southwest direction.

Game-Coin Enclosure was 35.5 and 29.5 percent of total hits with hits other than cover comprising 64.5 and 70.5 percent of total hits. The vegetation was composed of 35.5 and 41.2 percent shrubs, 34.2 and 23.7 percent grasses, 18.2 and 11.8 percent forbs, 10.6 and 21.0 percent half-shrubs, and 1.6 and 2.3 percent trees. The density of vegetation was estimated to be 1.3 and 2.5 plants per square foot (De Lorenzo 1974).

The large variations of composition, cover, and density between the two years was partially attributed to the amount and pattern of precipitation during the study (De Lorenzo 1974).

Water availability. The Gila River flows through the study area in a general northeast to southwest direction (Figure 76). Essentially, all surface runoff from the northwestern part of the study area enters the Gila River drainage system.

Fifteen water sources were located within the study area (Figure 77 and Appendix 25). The majority of these consist of naturally-occurring springs and seeps located in close proximity to open, rugged areas providing good visibility and escape terrain.

History of bighorn occupancy. At White Rock, on the Gila River north of Lordsburg, a ram is known to have been killed around 1900, and it was reported that a few still remained in the Burro and Carlisle (Steeplerock) Mountains; in 1908, Goldman and Bailey could obtain no recent records for this region (Bailey 1931:21).

Land status and use. Forty-three percent of the Burro-Gila Middle Box is administered by the Bureau of Land Management, 21 percent is patented land, 15 percent is national forest, 10 percent is water power projects withdrawal, and 10 percent is state lands (Table 23).

Table 23. Land status in the Burro Mountains-Gila Middle Box.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
BLM	39	24,960	10,101	43
Patented land	19	12,160	4,921	21
U.S. Forest Service	14	8,960	3,626	15
State land	9	5,760	2,331	10
Powersite withdrawal	7	4,480	1,813	8
Reclamation and water power	2	1,280	518	2
Totals	90	57,600	23,310	99

Ranching is the major land use activity in this area; however, the steep slopes, rock ledges, and escarpments tend to restrict grazing to the more gentle topography. Some mining is being done north of Red Rock, on the west side of the Gila River.

Results. A total of 90 square miles (233 sq km) were qualitatively

evaluated in the Burro Mountains-Gila Middle Mox area as potential desert bighorn habitat; forty-two percent was classified as good to optimum habitat (Table 24 and Figure 78). Twenty-nine percent of the area classified as suitable habitat is within the Gila National Forest.

Table 24. Evaluation of the Burro Mountains-Gila Middle Box as desert bighorn habitat.

Habitat Rating		Available Habitat			
Points	Category	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	1	640	259	1
51 to 64	Buffer zone	8	5,120	2,072	9
65 to 79	Zone of deficiency (marginal habitat)	43	27,520	11,137	48
80 to 100	Impt. to bighorn (good habitat)	34	21,760	8,806	38
100+	Vital to bighorn (optimum habitat)	4	2,560	1,036	4
Totals		90	57,600	23,310	100

Alamo Hueco Mountains

Study area. The Alamo Hueco (Spanish-hollow cottonwood) Mountains are located in Hidalgo County about 70 miles (112 km) southeast of Lordsburg in the extreme southwest corner of the state. The mountains are situated five miles (8 km) south of the Big Hatchets and extend to the border of the Republic of Mexico (Figure 79). The two ranges are connected by a series of low hills.

The Alamo Hueco Mountains consist of Tertiary volcanic rocks (Ungnade 1965) which rise some 1,600 feet (488 m) above the surrounding desert to a maximum elevation of 6,417 feet (1,956 m) at Pierce Peak. The topography along the northwest, north, and northeast flanks is characterized by numerous outcrops of bedrock forming vertical cliffs (Figure 80). In general, the south side of the mountain consists of undulating topography, bisected by numerous large north-south drainages. Horse Canyon drains to the south and bisects the mountain in two. Emory Canyon is the major drainage on the northern flank.

Climate. The Alamo Hueco Mountains have an arid, continental climate, characterized by light precipitation totals, large diurnal and annual temperature changes, plentiful sunshine, and low humidities.

Precise weather data for the area are lacking. The most representative weather recording station is at Hatchita (elevation 4,504 feet-1,478 m) located about 20 miles (32 km) north of the Alamo Hueco Mountains. The average annual precipitation for Hatchita is 9.63 inches (24.4 cm). Fifty-seven percent of the annual precipitation falls between July and September as brief afternoon and evening thundershowers. July receives the greatest amount of precipitation with an average of 2.16 inches (5.5 cm). April receives the least precipitation with an average of .12 inches (.30 cm) (Figure 81). The

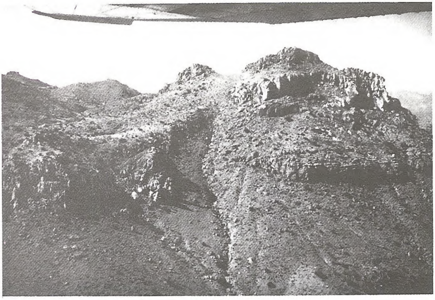


Figure 80. The topography of the Alamo Hueco Mountains is characterized by numerous outcrops of bedrock forming vertical cliffs.

mean annual temperature for Hatchita is 59.1 degrees F. (15.2° C.). December is the coldest month with an average temperature of 41.3 degrees F. (5.2° C.). July is the warmest with a mean maximum temperature of 78.3 degrees F. (25.9° C.) (Figure 81).

Soils. Soils of the Alamo Hueco Mountains include the Rock Land-Haplargids association. These soils are developing in material of igneous origin; however, limestone and other types of sedimentary rocks have contributed varying amounts to the parent materials.

Rock Land, a miscellaneous land type, is a complex of very shallow soils and rock outcrops. The bedrock usually occurs as vertical or nearly vertical exposures. A thin mantle of cobbly or stony soil commonly occurs between the outcrops of bedrock.

The Haplargids commonly occur on moderately steep landscapes. These

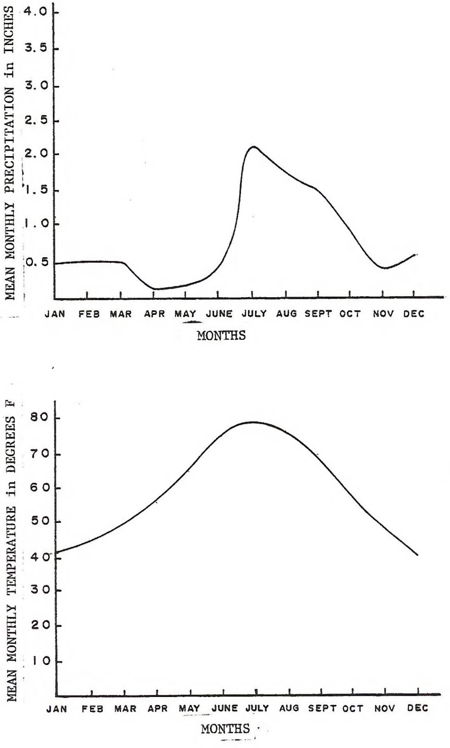


Figure 81. Mean monthly precipitation and temperatures for Hatchita, New Mexico, from 1966 to 1976.

soils usually have thin, moderately coarse and medium-textured surface layers over moderately well-developed subsoils. Gravel, cobble, and stones frequently occur in both surface and subsoil layers (Maker *et al*. 1974).

Vegetation. The Lower Sonoran Life Zone typifies much of the mountain range. An extensive grassland type characterizes the majority of the mountain. Associated species are mostly desert shrubs; however, a mixed shrub/ grass type is found within canyon bottoms, on adjacent protected slopes, and below cliffs (Figure 82). Plants identified from the Alamo Hueco Mountains are listed in Appendix 26.

The grassland community consists of grama, muhly (*Muhlenbergia* spp.), dropseed, three awns, wolf tail (*Lycurus phleoides*) and silver blue-stem (*Andropogon saccharoides*), with a scattered canopy of juniper trees, oakbrush, snakeweed, and a few other shrubs. Vegetative cover was estimated at 30 percent and the relative botanical composition at 75 percent graminoids, 15 percent trees and shrubs, and 10 percent forbs.

The mixed shrub/grass community is characterized by oak (*Quercus* spp.), little leaf sumac, spice-bush (*Aloysia wrightii*), Mormon tea, sacahuista, and turpentine bush. The understory consists mainly of grama, three awn, squirrel tail (*Sitanion hystrix*) and dropseed. Vegetative cover was estimated at 40 percent and the relative composition at 60 percent shrubs and trees, 30 percent grasses, and 10 percent forbs.

Water availability. Twenty-one water sources were located within and adjacent to the Alamo Hueco Mountains (Figure 82 and Appendix 27). The majority of these are limited to manmade sources. A small flowing spring is located in Cottonwood Canyon on the east side, and some seepage occurs at intervals in Horse Canyon. Water is also available most of the year at Dog Springs located in the extreme southern portion of the Alamo Huecos.

Windmills and stock tanks provide a reliable source of water; however, due to recent management changes at the U-Bar Ranch, some windmills have been cut off and in one instance (Sycamore Well), dismantled.

The large numbers of deep wells, pumps, and irrigated areas in the Playas Valley on the west side of the Hatchet-Alamo Hueco Mountains complex may have a major impact on the water table and animal distribution in future years.

History of bighorn occupancy. Mearn's party collected sheep from the Dog Mountains in 1892-93 (Mearns 1907). A large ram was killed on September 11, 1893, within 500 yards (457 m) of Dog Spring (Buechner 1960). Mearns (1907) includes what is now known as the Alamo Hueco Mountains with the Dog Mountains and gives the impression that sheep were rather common. Gordon (1953) wrote that Mr. Van Ormen, who was foreman and had occupied the Dog Springs ranch for several years, saw four sheep and at another time eight in the rugged canyons. Ramon Pavella, who has resided in the area longer than anyone else, stated that in 1898, he was herding sheep with his father in Sycamore Canyon on the southeast side of the Alamo Huecos. A large bighorn ram came up and joined their flock of domestic sheep. The ram proved so troublesome that he had to be driven away. Mr. Bill McKinney relates seeing bighorn in the Emory Canyon-Pierce Peak area about 1915. Lewis Lynch saw three ewes and one ram in this same area in the spring of 1941 (Gordon 1953).

Land status and use. Approximately 54 percent of the area evaluated as potential desert bighorn habitat is administered as public lands by the Bureau of Land Management. Pacific Land and Cattle Company, a subsidiary of Phelps-Dodge Corporation, owns about 43 percent, which is known as the U-Bar Ranch, and 3 percent of the area is state owned (Table 25).

Pacific Land and Cattle Company has restricted all public access into the Alamo Hueco Mountains. The major land use is grazing by domestic livestock.

Table 25. Land status in the Alamo Hueco and Dog Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
BLM	44	28,160	11,396	54
Patented lands	35	22,400	9,065	43
State lands	2	1,920	777	3
Totals	81	51,840	20,979	100

Approximately 2,600 animal unit months are allowed by permit. However, the mountain has not been intensively grazed for three years. Localized areas currently being grazed include Horse Canyon, Dog Springs, Wood Canyon, Petersons and Jansen Wells (Mat Ormen, foreman, U-Bar Ranch, pers. comm., February 21, 1978).

Results. Sixty-six square miles (172 sq km) were qualitatively evaluated as potential desert bighorn habitat in the Alamo Hueco Mountains (excluding the Dog Mountains). Thirty-two percent of the area evaluated was classified as good habitat, 32 percent as marginal habitat, and 33 percent as a buffer zone (Table 26 and Figure 83). Areas that are classified as buffer zone are ones which should be retained at least in their present status as a buffer against human encroachment. However, these areas may be improved upon for bighorn sheep use in various ways through habitat manipulation or by change in human use.

Table 26. Evaluation of the Alamo Hueco Mountains as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Score	Rating	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	-	-	-	-
51 to 64	Buffer zone	22	14,080	5,698	33
65 to 79	Zone of deficiency (marginal habitat)	21	13,440	5,439	32
80 to 100	Impt. to bighorn (good habitat)	21	13,440	5,439	32
100+	Vital to bighorn (optimum habitat)	2	1,280	518	3
Totals		66	42,240	17,094	100

Big Hatchet Mountains

Study area. The Big Hatchet Mountains are located in Hidalgo County about 60 miles (96 km) southeast of Lordsburg in the extreme southwest corner of the state. The mountain range extends in a north-south direction for about 14 miles (22 km) and varies about 6 miles (10 km) in width (Figure 84).

The geologic structure of the Big Hatchets is a tilted fault block of limestone strata, with a precipitous west-facing escarpment and relatively gentle southeast-facing slopes (Figure 85). Thrusting in the Big Hatchets was toward the west and southwest. The majority of the range is composed of Horquilla Limestone with a small area of El Paso Limestone and Montoya Dolomite near the northern end starting at Horse Pasture Canyon. A larger area of Epitaph Dolomite appears in the southwestern section (Hayward et al. 1978).

Elevation varies from 4,129 feet (1,258 m) at Artesian Well in the Hatchita Valley to 8,366 feet (2,550 m) on Big Hatchet Peak. Average elevation is about 6,000 feet (1,829 m).

Climate. Limited weather data were obtained for the Big Hatchets during the recently-completed studies. The rain gauge was located at Mengus Tank

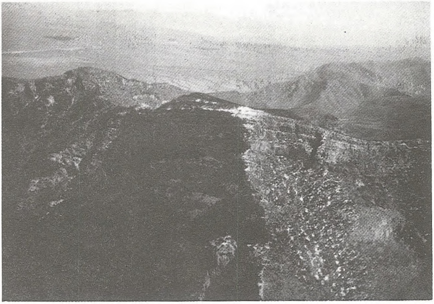


Figure 85. The precipitous west-facing escarpment of Big Hatchet Peak (8,366 feet-2,550 m)m and the relatively gentle southeast-facing slopes.

(elevation, 4,371 feet-1,332 m) on south end of the mountain. Temperature information was recorded daily at 6:00 p.m. at base camp located at the Hatchet Ranch (elevation, 4,268 feet-1,301 m) (Watts 1978).

The annual precipitation for 1977 was 12.5 inches (31.8 cm). Fifty-five percent of the precipitation occurred between August and October. October received the greatest amount with 2.4 inches (6.1 cm); March received the least with .17 inches (.44 cm) (Table 27). The mean annual temperature was 60.2 degrees F. (15.8° C.). January was the coldest month with a temperature of 44.6 degrees F. (7.0° C.); July was the warmest with a temperature of 79.7 degrees F. (26.7° C.) (Figure 86).

Soils. Soils in the Big Hatchet Mountains include the Rock Land-Haplargids association. Characteristic features of this unit are the steep to extremely steep slopes, shallow and rocky soils with numerous exposures of bedrock.

graminoids, 20 percent trees and shrubs, and 10 percent forbs (Figure 36).

Plants occurring in the San Mateo Mountains are listed in Appendix 10.

Water availability. The San Mateo Mountains, due to their high elevation, apparently receive sufficient annual moisture and hence have a higher potential of free water production during the critical late spring-early summer months. Numerous springs and seeps are found throughout the mountain (Figure 36 and Appendix 11). Some of these are located within deep timbered canyons (Nave, Turkey, Oak, and Whitetail Springs).

History of bighorn occupancy. Early records do not mention the San Mateo Mountains as historical bighorn sheep range. However, it is conceivable that bighorn occupied the area due to the close proximity of the Magdalena Mountains which are historic sheep range.

Land status and use. Ninety-six percent of the area evaluated as bighorn habitat is administered by the U.S. Forest Service. Three tracts of land, totaling approximate 640 acres (259 ha) are privately owned; 320 acres (129 ha) in Rock Spring Canyon, 160 acres (65 ha) near the mouth of Shipman Canyon, and 160 acres (65 ha) in San Mateo Canyon.

Results. Twenty-nine square miles of the southern San Mateo Range were qualitatively evaluated as potential bighorn habitat. Sixty-five percent of the area evaluated was considered as marginal habitat (zone of deficiency) and 24 percent was considered as good habitat (important for desert bighorn) (Table 12 and Figure 37).

Table 12. Evaluation of the southern San Mateo Mountains as potential bighorn sheep habitat.

Habitat Rating		Available Habitat			
Category	Points	Acres	Hectares	Square Miles	Percent
Not important to bighorn	0 to 50				
Buffer zone	51 to 64	1,920	777	3	11
Zone of deficiency (Marginal habitat)	65 to 79	12,160	4,921	19	65
Important to bighorn (Good habitat)	80 to 100	4,480	1,813	7	24
Vital to bighorn (Optimum habitat)	100+	0	0	0	0
Totals		18,560	7,511	29	100

Magdalena Mountains

Study area. The Magdalena Mountains are located about 12 miles (19 km) west of Socorro. The study area encompassed the mountain complex from U.S. Highway 60 south to Milligan Gulch (Figure 38). Geologically speaking, the core of the Magdalenas is granite, overlain with limestone and partially covered by Tertiary volcanics (Ungnade 1965). The topography is highly bisected by deep, narrow canyons, particularly on the east and southeast side. Numerous talus dot the steep, timbered slopes on the east and west aspects (Figure 39). Elevation varies from 5,500 feet (1,676 m) along the southern end to 10,783 feet (3,287 m) at South Baldy, for a total relief of 5,300 feet (1,615 m).

Climate. Mean annual precipitation for the town of Magdalena (elevation 6,441 feet-1,963 m) is 11.49 inches (29.2 cm). Precipitation increases with elevation to average annual amounts of 15 to 20 inches (38.7 to 50.8 cm) in the Magdalena Mountains. Average annual snowfall ranges from a few inches along the piedmont where it seldom remains on the ground for more than a few hours, to between two and three feet (.60 to .91 m) at higher elevations

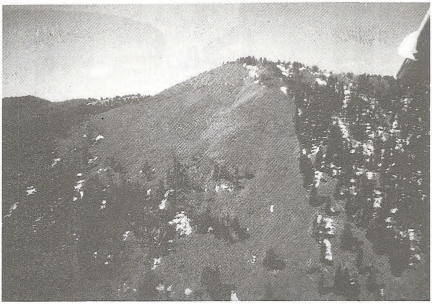


Figure 39. Extensive talus dot the steep timbered slopes on the east and west slopes of the Magdalena Mountains.

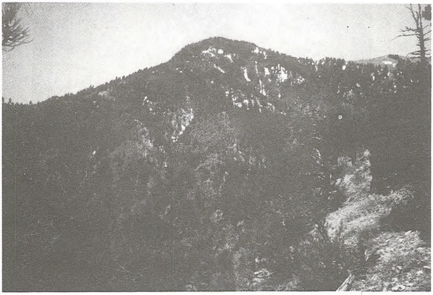


Figure 41. A mixed coniferous forest characterizes higher elevations in the Magdalena Mountains.

(Allyn Wasser, Magdalena District Ranger, pers. comm., April 18, 1978). Six-foot (1.8 m) snowdrifts were still present above 10,000 feet (3,048 m) when field work was conducted in April 1978.

Soils. Soils of the Magdalena Mountains consist mainly of the Argiborolls-Cryoborolls-Ustorthent association. The soils are developing dominantly in parent materials from mixed igneous and conglomerate rocks. They are typically dark colored, with a moderate to high content of organic matter, and neutral to slightly acid in reaction. The surface layers are often gravelly and occasionally stony (Maker *et al.* 1974).

Rock Land, a miscellaneous land type, is also an important component of this association in these mountains. It generally is very steep and consists of a complex of very shallow soils and outcrops of bedrock with numerous talus.

Vegetation. Merriam's Life Zones represented in the Magdalena Mountains include the Upper Sonoran, Transition, Canadian, Hudsonian, and Subalpine (Figure 40). The Magdalena Mountains feature an oak-shrub/pinon-juniper type at lower elevations interspersed with relatively small open areas supporting mountain mahogany, blue grama, June grass (*Koeleria cristata*), and Arizona fescue (*Festuca arizonica*). Three canopy layers are evident in this type, accounting for an estimated average coverage of over 100 percent. Trees comprise about 75 percent, shrubs approximately 30 percent, and grasses and forbs account for about 20 percent of the floristic composition.

A mixed coniferous forest characterizes higher elevations in the Magdalena Mountains. This community is typified by Douglas fir, ponderosa pine, limber pine (*Pinus flexilis*), white fir (*Abies concolor*), and quaking aspen (*Populus tremuloides*) (Figure 41). Canopy coverage in this type was estimated at over 100 percent.

Interrupting this subalpine forest are herb-dominated meadows whose

floristics contrast sharply with the adjacent coniferous community (Figure 42). These meadows are typified by an extensive mixed grass community (Arizona fescue, June grass, and mountain muhly-*Muhlenbergia montana*), with patches of shrubs such as rockspirea and currants (*Ribes montigenum*). The total canopy coverage of this type was estimated at 30 percent and the relative composition at 75 percent graminoids, 15 percent shrubs, and 10 percent forbs.

Plants identified from the Magdalena Mountains are listed in Appendix 12.

Water availability. The Magdalena Mountains are relatively well-watered; forty-five water sources were located (Figure 40 and Appendix 13). Most of these consist of undeveloped springs and seeps located in deep timbered canyons. A permanent stream is found in Sawmill Canyon, and intermittent streams are found in Copper and North Fork Water Canyons.

History of bighorn occupancy. In 1905, Hollister reported old horns of mountain sheep in the Magdalena Mountains during the previous 25 years. All were very old, and no one appeared to know when bighorn were found in the region (Bailey 1931:21). This is the only record of bighorn occupancy in these mountains.

Land status and use. Sixty-four percent of the area evaluated as bighorn habitat is within the Cibola National Forest, 14 percent is public lands administered by the Bureau of Land Management, 12 percent is state lands, and 9 percent is patented lands. The tracts of patented lands are found scattered throughout the study area and range in size from about 160 acres (65 ha) to over 1,000 acres (405 ha). Most of these are located near the old mining town of Kelly on the northwest side of the mountain range (Table 13).

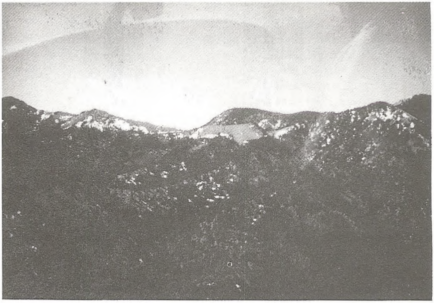


Figure 42. Interrupting the subalpine forest are herb-dominated meadows whose floristics contrast sharply with the adjacent coniferous community in the Magdalena Mountains.

Table 13. Land status in the Magdalena Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
U.S. Forest Service	94	60,160	24,346	64
Public domain	21	13,440	5,439	14
State lands	17	10,880	4,403	12
Patented lands	13	8,320	3,367	9
BLM acquired lands	1	640	259	.7
Totals	146	93,440	37,815	00.7

Land use activities include recreation, cattle grazing, research facilities, and mining on a small scale. The subalpine community along the summit is easily accessible by automobile as the New Mexico School of Mines maintains a laboratory on the prominent peak about one mile (1.6 km) south of Baldy Peak. The School of Mines road to the Atmospheric Research Laboratory crisscrosses

the steep slopes of Water Canyon, skirting the southeast side of South Baldy only a short distance from the top. The possibility exists of an additional 80 million dollar National Science Foundation structure on the summit (Allyn Wasser and Jerry Lopeman, pers. comm., April 18, 1978, Magdalena District Ranger and Recreation Specialist, respectively, Cibola National Forest).

The U.S. Forest Service maintains a developed campsite in Water Canyon. This site includes about 15 picnic tables, barbecue pits, and sanitary facilities.

Cattle graze the open and less precipitous portion of the mountain. The majority of the grazing is confined to lower slopes, drainages, and subalpine meadows. Cattle were observed grazing just below South Baldy in April 1978.

Prospectors were attracted to the Magdalena Mountains in 1879. A townsite was laid out on the west slope of the mountain range, and named Kelly. During the 1880's, Kelly experienced a promising growth and much activity. However, by 1931, mining throughout the area began to decrease (Sherman and Sherman 1975). Extensive mine workings, tailing dumps, old mine buildings, and head frames are the only remains of the prosperous townsite of Kelly. Today some mining is still being done in this area.

Results. A total of 146 square miles (378 sq km) were qualitatively evaluated in the Magdalena Mountains as potential bighorn habitat. Seventy-seven percent of this area is administered by the U.S. Forest Service. Sixty-one percent of the area evaluated was classified as marginal habitat, 26 percent as a buffer zone, and 12 percent as good habitat (Table 14 and Figure 43).

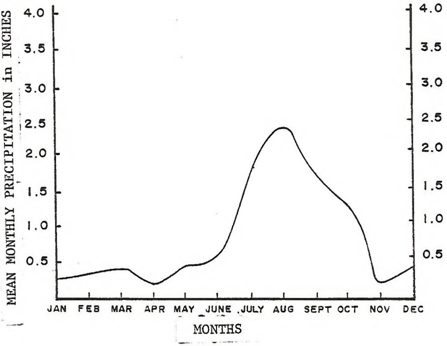
Table 14. Evaluation of the Magdalena Mountains as potential bighorn habitat.

Habitat Rating		Available Habitat			
Points	Category	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	1	640	259	1
51 to 64	Buffer zone	38	24,320	9,842	26
65 to 79	Zone of deficiency (marginal habitat)	89	56,960	23,051	61
80 to 100	Impt. to bighorn (good habitat)	18	11,520	4,662	12
100+	Vital to bighorn (optimum habitat)	0	0	0	0
Totals		146	93,440	37,815	100

Malpais

Study area. The study area included the Malpais (Spanish - "badlands") in Valencia County, from Interstate 40 at Grants, south and west for some 20 miles (32 km) to the Ice Caves (Figure 44). The topography is characterized by numerous pressure ridges, sink holes, and cinder cones. Until recently, no roads entered the area and the Malpais could be traversed only on foot. The volcanic activity in this region is very recent as attested by the fact that Pueblo Indian pottery dating from around 800 A.D. has been found in sand covered by the lava flow (Foster 1971). Elevation varies from 6,392 feet (1,948 m) near Grants to 8,372 feet (2,552 m) at Bandera Crater.

Climate. The most representative weather reporting station to the study area is located at Grants (elevation, 6,520 feet-1,987 m). The climate is semiarid continental. Winters are cold; summers are warm; and days are sunny. The average annual precipitation for Grants is 10.06 inches (25.5 cm). Seventy-three percent of the annual precipitation comes in summer, as brief afternoon and evening thundershowers. August receives the greatest amount of precipitation with an average of 2.46 inches (6.2 cm). April is the driest month with an average of .20 inches (.51 cm) (Figure 45). Snowfall is fairly



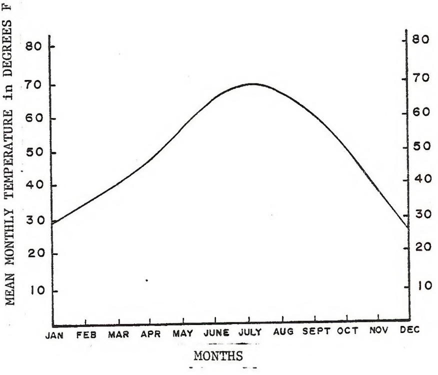


Figure 45. Mean monthly precipitation and temperatures for Grants, New Mexico, from 1966 to 1976

common, averaging from about 15 to 40 inches per year. Humidity is low, probably in the 30 to 50 percent range most of the time. Days are warm and nights are chilly in summer. The mean annual temperature is 48.6 degrees F. (9.3° C.). January is the coldest month with an average temperature of 28.2 degrees F. (-2.1° C.), and July is the warmest month with an average temperature of 70.7 degrees F. (21.6° C.) (Figure 45).

Soils. Soils of the Malpais are in the Lava Rock Land association, consisting of relatively recent basalt or lava flow. A distinctive feature is the extremely rocky and broken nature of the land surface. The basalt rock covering this area is very recent, so most of this association is practically devoid of soil and consists mainly of basalt rock and stones. Small and isolated pockets of soil, however, do occur intermingled throughout the lava flow. These small pockets of soil are medium to moderately fine in texture, while others are sandy. The sandy soils are forming dominantly in eolian sediments deposited over the basalt rocks and boulders (Maker *et al.* 1974).

Vegetation. Merriam's Life Zones represented in the study area include the Upper Sonoran and the Transition. Vegetation is sparse and is usually found growing in the cracks and fractures in the basalt rocks (Figure 46). A fair cover of native vegetation including short and mid grasses, shrubs, and a few trees is found in small and isolated pockets of deeper soils (Appendix 14 and Figure 47).

Ponderosa pine and Gambel's oak dominate the overstory at higher elevations. The understory consists of scattered mountain mahogany, wavy leaf oak (*Quercus undulata*), and cliffrose (*Cowania stansbursiana*). Vegetative cover was estimated at 20 percent and the relative botanical composition at 75 percent trees, 20 percent shrubs and less than 5 percent forbs.

An open shrub/grass community is found at lower elevations. This

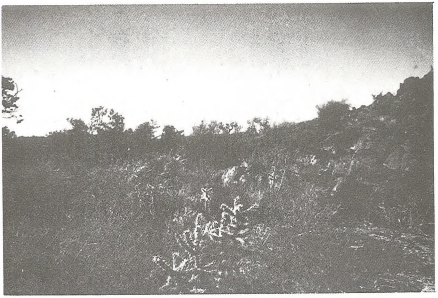


Figure 46. Vegetation in the Malpais is sparse and is found growing in the cracks and fractures in the basalt rock.

community is dominated by mountain mahogany, cliffrose and scattered grasses such as side oats grama, Indian ricegrass (Oryzopsis hymenoides), and sand dropseed (Sporobolus cryptandrus). Canopy coverage was estimated at 15 percent and the relative composition at 70 percent shrubs, 25 percent grasses and 5 percent forbs.

Water availability. Water is restricted to seasonal potholes and windmills along the periphery of the lava flow (Figure 47 and Appendix 15). The water table in the study area has been greatly reduced over the past 30 years (Sands 1963). Sands (1963) also stated that there had been many water-filled potholes in the lava flow, and although some were still present, the water level had receded considerably. In one cavern near the Ice Caves, the water level had dropped several feet and it is now almost dry.

History of bighorn occupancy. Most of the available data concerning the

past existence of bighorn sheep in the Malpais and Zuni Mountains has been summarized by Buechner (1960). No reliable reports of live sheep have been recorded since Coronado reported them in 1540. Ned Hollister, in 1905, reported old horns found during the previous 25 years in the Zuni Mountains, but no one living in the area could remember seeing live sheep. Well-preserved horns of mountain sheep have been found in the Malpais. These horns were found in caves, sink holes and among the lava flow. Mr. Dave Candelaria, landowner and proprietor of the Ice Caves, has two bighorn skulls that he found in 1951 in the lava flow near the Ice Caves. One skull is blackened by smoke and only a part of the outer horn sheath remains. The second skull lacks the lower jaw and both horn sheaths (Figure 48).

On the basis of two skulls submitted by J. Stokley Ligon to the U.S. National Museum, the bighorn formerly occupying this area were thought by Bailey to represent *mexicana* (Buechner 1960). To date, it has never been clearly established which subspecies historically occupied the area.

Land status and use. Land ownership in the Malpais is a checkerboard pattern. Approximately 64 percent of the area evaluated is patented land, 20 percent is public land administered by the Bureau of Land Management, and 15 percent is state land.

Use of the lava flow and adjacent country by livestock has varied. Over much of the area, use has been excessive and in some instances, still is. Cattle, horses, domestic sheep and goats have grazed the area in the past. Presently, cattle, horses and domestic sheep range the fringes of the lava flow, while very little use is made of the rougher portions.

Results. A total of 254 square miles (658 sq km) was qualitatively evaluated in the Malpais as potential bighorn habitat. Sixty-eight percent of the total area evaluated was classified as marginal habitat (zone of

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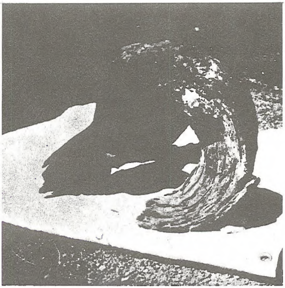

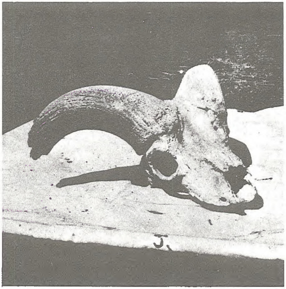

Figure 48. Bighorn skulls found in the Malpais. One skull (top) is blackened by smoke and only a part of the outer horn sheath remains, the second skull lacks the lower jaw and both horn sheaths.

deficiency), 23 percent as a buffer zone (area that should be retained in its present state as a buffer against human encroachment) and seven percent as not important to bighorn (Table 15 and Figure 49).

Table 15. Evaluation of the Malpais as desert bighorn habitat.

Habitat Rating		Available Habitat			
Points	Category	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	18	11,520	4,662	7
51 to 64	Buffer zone	58	37,120	15,022	23
65 to 79	Zone of deficiency (marginal habitat)	174	111,360	45,067	68
80 to 100	Impt. to bighorn (good habitat)	4	2,560	1,036	2
100+	Vital to bighorn (optimum habitat)	0	0	0	0
Totals		254	162,560	65,787	100

Ladron Mountains

Study area. The Ladron Mountains (Spanish-mountain of thieves) are located near the center of the state, approximately 28 miles (45 km) northwest of Socorro and 52 miles (83 km) southwest of Albuquerque (Figure 50). The mountain is about 10 miles (16 km) long from north to south and averages about six miles (10 km) in width. The north side of the mountain (Figure 51) consists largely of granite, quartzite and other Precambrian rocks while the west side (Figure 52) is characterized by more recent sedimentary strata. These mountains rise from desert plains at approximately 5,600 feet (1,707 m) to 9,176 feet (2,797 m), giving a maximum relief of about 3,700 feet (1,128 m), and placing the majority of the peaks above 7,000 feet (2,134 m).

Climate. Climate on the Ladron Mountains is characteristic of southwestern semiarid mountains. Summer temperatures are moderately warm, with the maximum temperatures averaging above 90 degrees from June through August. There is considerable cooling at night and the average daily temperature range

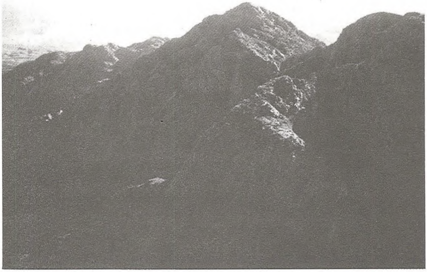

Figure 51. The north side of the Ladron Mountains consists of granite, quartzite and other Precambrian rocks.

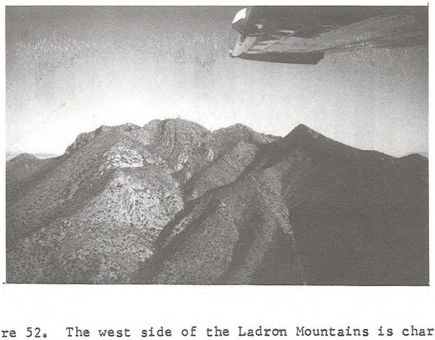

Figure 52. The west side of the Ladron Mountains is characterized by more recent sedimentary strata.

exceeds 30 degrees F. (-1.1° C.). Winter temperatures on the mountain are characterized by cool daytime temperatures and cold nights. From mid-November to mid-March, temperatures fall well below freezing at night and occasionally are below zero (BLM 1975).

No precise precipitation data are available for the Ladron Mountains; the estimated annual precipitation is 12 inches (30.4 cm). The nearest reporting station is Belen, located approximately 25 miles (40 km) northeast, along the Rio Grande Valley. Mean annual precipitation for Belen is 8.67 inches (22.0 cm). Sixty-five percent of the yearly precipitation occurs during brief afternoon and evening thunderstorms from July through October (Figure 53). Winters are relatively dry. Some of the winter precipitation is in the form of snow.

Soils. Soils in the Ladron Mountains include the Rock Land-Chimayo-Luzena association (Maker *et al.* 1974). These soils are generally stony or gravelly and shallow and are forming dominantly in materials weathered from a wide variety of igneous rock. Rock outcrops and talus are common on the steep side slopes below upland ridges.

Vegetation. Merriam's Life Zones represented in the Ladron Mountains include the Upper Sonoran and the Transition with a few indicators of the Canadian. Vegetative communities were considered to be subclimax due to apparent past overutilization of the forage by domestic sheep and goats. Decadent isolated pockets of Douglas fir and aspen suggest prolonged drought or changes in overall climatic conditions on the mountain. Isolated pockets contain heavy stands of juniper and moderate stands of ponderosa pine. Oak occurs in dense stands under the rocky cliffs and is scattered among the highest ridges. Moderate to dense stands of grass grow over most of the higher elevations (Figure 54 and Appendix 16).

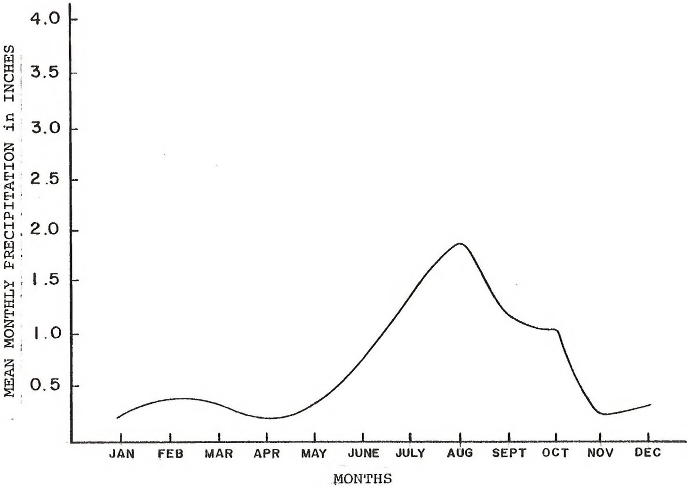

Figure 53. Mean monthly precipitation for Belen, New Mexico, from 1966 to 1976.

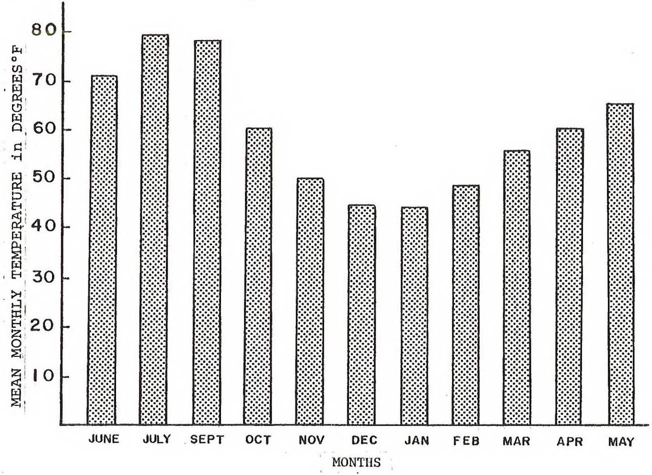

Figure 86. Mean monthly temperatures for the Big Hatchet Ranch, Hidalgo County, New Mexico, during 1977.

Table 27. Monthly precipitation for the Big Hatchet Mountains during 1977.*

Month	Precipitation	
	Inches	Centimeters
January	1.26	3.20
February	.38	.97
March	.17	.44
April	.97	2.46
May	.23	.59
June	1.21	3.08
July	1.91	4.87
August	2.09	5.33
September	.50	1.28
October	2.40	6.10
November	.90	2.28
December	.52	1.33
Total	12.54	31.85

*Gauge located at south end of Big Hatchet Mountains.

These soils are developing in material of limestone; however, other types of sedimentary rocks have contributed varying amounts to the parent materials (Maker _et_ _al_. 1974).

Rock Land is a complex of very shallow soils and rock outcrops. A large amount of loose rock occurs on the surface. A thin mantle of cobbly or stony soil material commonly occurs between the outcrops of bedrock. Although the intermingled soils are dominantly shallow, small areas of moderately deep soils occur as pockets among the rock outcrops and ledges.

The Haplargids occur on moderately steep slopes. These soils usually have thin, moderately coarse and medium-textured surface layers over finer-textured, well-developed subsoils. Gravel, cobble, and stones frequently occur in both surface and subsoil layers (Maker _et_ _al_. 1974).

Vegetation. Merriam's Life Zones represented in the mountain range include the Lower and Upper Sonoran. Exposed slopes are vegetated by a desert shrub/grass community consisting of mariola, white thorn, senna (_Cassia_

wislizeni), prickly pear cactus, New Mexico muhly (Muhlenbergia pauciflora), side oats grama, and six weeks three awn (Aristida adscensionis). This community intergrades into a mixed shrub type above 6,000 feet (1,829 m). The mixed shrub type is characterized by mariola, mountain mahogany, shrub live oak, evergreen sumac (Rhus choriophylla), sotol, yucca (Yucca baccata) and prickly pear cactus.

Protected sites are vegetated by a mixed shrub/grass community below 6,000 feet (1,829 m). This community is dominated by mariola, spice bush, evergreen sumac, grama, three awns, and slim tridens (Tridens muticus). A piñon-juniper woodland occurs above 6,000 feet (1,829 m), reaching its maximum development north of Big Hatchet Peak at the head of Chainey Canyon. This type also occurs in small pockets on protected sites in Thompson Canyon; however, it is not well-represented south of this major east-west drainage.

Vegetational characteristics of desert bighorn sheep high use areas in the southern Big Hatchets were determined by Watts (1978). Three high-use areas were sampled. The mean vegetative cover varied from 19 percent at Cairn Hills to 32 percent in the New Well Peak area for an overall average vegetative cover of 27 percent. The relative floristic composition was 58 percent shrubs, 26 percent graminoids, and 15 percent forbs (Watts 1978).

A list of plants collected in the Big Hatchet Mountains is found in Appendix 28.

Water availability. Naturally-occurring water sources are non-existent in the Big Hatchet Mountains. The Hatchet Ranch installed the first permanent water source (Sheridan Well) within the mountain about 40 years ago (Mahlon Everhart, owner, Hatchet Ranch, pers. comm., July 31, 1978). Seven umbrella and apron water catchment units were constructed during the 1950's and 1960's by the New Mexico Department of Game and the Bureau of Land Management. There

are permanent and seasonal water sources maintained for cattle around the periphery of the mountain.

Eighteen water sources were located within or in close proximity to the Big Hatchet Mountains (Figure 87 and Appendix 29). Many of these sources, including the water catchment units, frequently become dry in spring during years of average rainfall, and assuredly would be dry much of the time during years of below-average precipitation.

History of bighorn occupancy. In 1892, Mearns found bighorn inhabiting the Big Hatchet Mountains. He wrote, "Edward Rector and Jack Doyle had killed many bighorns on the Hachita Grande Mountain in Grant County, N. Mex., where I saw six in 1892 in the canyon at the east base" (Mearns 1907, p. 239). The population of bighorn sheep in the Big Hatchets apparently was reduced greatly by 1908 when E. A. Goldman of the U.S. Biological Survey (now the U.S. Fish and Wildlife Service) was informed by a ranchman that only a few sheep remained there and that probably none remained in other ranges of southwestern New Mexico (Bailey 1931).

The Big Hatchet State Game Refuge encompassing some 105,534 acres (42,709 ha) was established by the State Game Commission in 1924 for the protection of bighorn. During the early 1950's, between 125 and 150 bighorn were estimated to occupy the area (Gordon 1957). Since then, the population has dwindled to a currently estimated 15 to 20 sheep (Watts 1978). The initial decline was attributed to severe drought and hence competition with deer and domestic livestock in an already depleted range (Gross 1960).

Land status and use. Eighty-three percent of the area evaluated as desert bighorn habitat in the Big Hatchets is public lands administered by the Bureau of Land Management. Sixteen percent is state land and less than 1 percent is patented land (Table 28 and Figure 87).

Table 28. Land status in the Big Hatchet Mountains.

Ownership	Area Sq Mi	Acres	Hectares	Percent
BLM	75	47,960	19,409	83
State land	14	8,960	3,626	16
Patented land	-	40	16	.07
Totals	89	56,960	23,051	99.07

The major land use activity is cattle grazing. Cattle utilization from December to June is normally restricted to areas between 4,000 and 5,000 feet (1,219 to 1,524 m) elevation. This range delineation is applicable when environmental conditions approach normal, but may vary with forage and water availability.

The Big Hatchets are currently being considered for wilderness designation by the Bureau of Land Management. If these mountains are designated as a wilderness, the possibility exists of outdoor recreation (hiking, backpacking) becoming a major land use activity in the area.

Results. Eighty-nine square miles (231 sq km) were qualitatively evaluated as desert bighorn habitat. Twenty-two percent of the area was classified as good habitat, 31 percent as marginal habitat (zone of deficiency), while 25 percent was classified as a buffer zone (Table 29 and Figure 88).

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Table 29. Evaluation of the Big Hatchet Mountains as desert bighorn habitat.

Habitat Rating		Available Habitat			
Points	Score	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	15	9,600	3,885	17
51 to 64	Buffer zone	22	14,080	5,698	25
65 to 79	Zone of deficiency (marginal habitat)	28	17,920	7,252	31
80 to 100	Impt. to bighorn (good habitat)	20	12,800	5,180	22
100+	Vital to bighorn (optimum habitat)	4	2,560	1,036	5
Totals		89	56,960	23,051	100

These data were analyzed three ways, combined (the entire mountain range), a northern portion, and a southern portion. The mountain range was divided into two sectors along the Thompson Canyon-Sheridan Canyon Divide (Bugle Ridge). This ridge demarcates the abrupt change in topography, with the area to the north characterized by steep slopes and numerous outcrops of bedrock forming nearly vertical cliffs (Figure 89). The area to the south is more subdued, lacking precipitous escarpments (Figure 90).

The southern portion of the mountain range receives the majority of the sheep use. A few rams might occasionally venture into the rugged northern portion; however, this has not been substantiated during the recently-completed study (Watts 1978).

A total of 35 square miles (91 sq km) were evaluated in the northern portion of the mountain. Forty-three percent of the area was classified as good habitat for desert bighorn, and 11 percent as optimum habitat (Table 30).

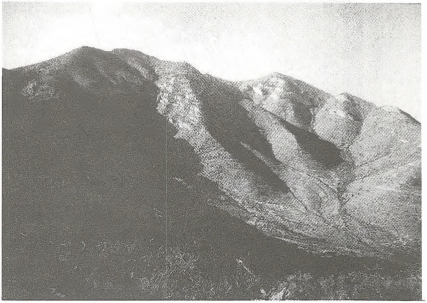


Figure 89. The area north of Thompson Canyon is characterized by steep slopes and numerous outcrops of bedrock.

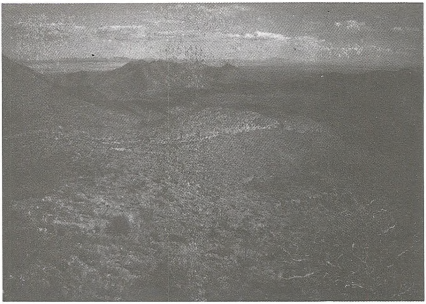


Figure 90. The area south of Thompson Canyon is more subdued, lacking precipitous escarpments. The New Well Peak (6,191 feet-1,887 m) complex is at far left.

Table 30. Evaluation of the northern Big Hatchet Mountains as desert bighorn habitat.*

Habitat Rating		Available Habitat			
Points	Score	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	4	2,560	1,036	11
51 to 64	Buffer zone	4	2,560	1,036	11
65 to 79	Zone of deficiency (marginal)	8	5,120	2,072	23
80 to 100	Impt. to bighorn (good habitat)	15	9,600	3,885	43
100+	Vital to bighorn (optimum)	4	2,560	1,036	11
Totals		35	22,400	9,065	99%

*area north of Thompson Canyon

Fifty-four square miles (140 sq km) were evaluated in the southern portion of the mountain. Nine percent was classified as good habitat, 37 percent as marginal habitat, and 33 percent as buffer zone (Table 31).

Table 31. Evaluation of the southern Big Hatchet Mountains as desert bighorn sheep habitat.*

Habitat Rating		Available Habitat			
Points	Score	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	11	7,040	2,849	20
51 to 64	Buffer zone	18	11,520	4,662	33
64 to 79	Zone of deficiency (marginal habitat)	20	12,800	5,180	37
80 to 100	Impt. to bighorn (good habitat)	5	3,200	1,295	9
100+	Vital to bighorn (optimum habitat)	-	-	-	-
Totals		54	34,560	13,986	99%

*area south of Thompson Canyon to include Cairn Hills

Little Hatchet Mountains

Study area. The Little Hatchet Mountains are located in Hidalgo and Grant Counties about 35 miles (56 km) south of Lordsburg. These mountains

are separated from the Big Hatchets by Hatchet Gap (elevation, 4,318 feet-1,316 m), through which State Road 81 from Hatchita to Antelope Wells traverses (Figure 91).

The Little Hatchets extend north-south for about 15 miles (24 km) and average about five miles (8 km) in width. They reach an elevation of 5,585 feet (2,007 m), thus exhibiting a maxumum relief of about 2,000 feet (610 m) from the surrounding desert.

The geologic structure of these mountains is a fault block with moderately steep slopes, limited bedrock outcropping and precipitous escarpments. The topography is frequently bisected by ravines and small canones (Figure 92). The south end of the mountain is thrusted west along a northwest-to-southeast trending fault zone, exhibiting steep west-facing slopes and relatively gentle east slopes.

Climate. The climate of the Little Hatchet Mountains is typical of the desert mountains of southern New Mexico, characterized by little precipitation, large diurnal and annual temperature changes, plentiful sunshine, and low humidities.

Precise weather data for this area are lacking. The most representative weather recording station is at Hatchita (elevation, 4,504 feet-1,498 m) located about eight miles (12.8 km) northeast of the Little Hatchets. The average annual precipitation for Hatchita is 9.63 inches (24.4 cm). Fifty-seven percent of the annual precipitation occurs between July and September. July receives the greatest amount of precipitation with an average of 2.16 inches (5.5 cm). April receives the least precipitation with an average of .12 inches (.30 cm) (Figure 81, page 89). The mean annual temperature for Hatchita is 59.1 degrees F. (15.2° C.). December is the coldest month with an average temperature of 41.3 degrees F. (5.2° C.). July is the warmest month with

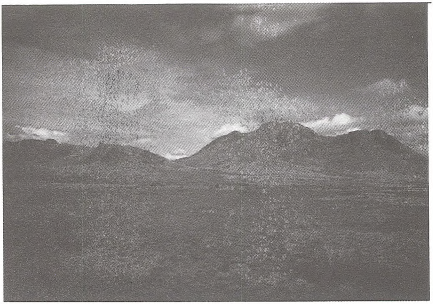


Figure 92. The geologic structure of the Little Hatchet Mountains is a fault block with moderately steep slopes, limited bedrock outcroppings and escarpments.

a mean maximum temperature of 78.3 degrees F. (25.9° C.) (Figure 81, page 89).

Soils. The soils in the Little Hatchet Mountains include the Rock Land-Lehmans association. Most of these soils are developing in materials from limestone, basalt, and igneous rocks.

Rock Land, a miscellaneous land type, is a major component of this association. It is a complex of very shallow soils and exposures of bedrock. The bedrock commonly occurs locally as nearly vertical exposures and ledges. A thin mantle of cobbly or stony soil material is found between outcrops of bedrock.

Lehmans soils occur on the moderately steep and hilly landscape. They usually have a thin surface layer of brown stony loam. The subsoil is a reddish-brown gravelly or stony clay (Maker *et al.* 1971).

Vegetation. Vegetation in the Little Hatchets is typical of the Lower

Sonoran Life Zone, consisting of a grass/desert shrub type at lower elevations, intergrading into a grass/mixed shrub type above 5,500 feet (1,676 m). Vegetative communities were found to differ in terms of total species density, but not composition between protected and exposed slopes. A list of plants occurring in the Little Hatchets is found in Appendix 30.

The grass/desert shrub community consists of silver beardgrass, little-bluestem (Andropogon scoparius), grama, three awns, soaptree yucca, sotol, turpentine bush, and snakeweed. The community occupies the moderately steep alluvial fans and is best represented along the southwest and southeast exposures of the mountain range. Silver beardgrass and little bluestem add a characteristic golden tinge to the landscape of the Little Hatchets as seen from Hatchet Gap. Vegetative cover in the community was estimated at 30 percent and the relative botanical composition at 50 percent graminoids, 40 percent shrubs, and 10 percent forbs.

A grass/mixed shrub community is situated on the steep and rocky slopes above 5,500 feet (1,676 m) (Figure 93). Although the density of vegetation is somewhat restricted here due to rock outcrops, thin soils, and steep slopes, this community does support a variety of grasses, shrubs, and a few scattered juniper trees. The grass/mixed shrub type is dominated by grama, muhly, dropseed, turpentine bush, mariola, yucca, cholla, and agave. Vegetative cover was estimated at 25 percent, the floristic composition at 50 percent grasses, 45 percent shrubs and half-shrubs, and about 5 percent forbs.

Water availability. Seven water sources were located around the base of the mountain (Figure 94 and Appendix 31). Cottonwood Spring, located on the west side about one mile (1.6 m) from the mountain and surrounded by creosote/mesquite, is one of the few naturally-occurring water sources. The remaining sources consist mainly of windmills scattered along the periphery.

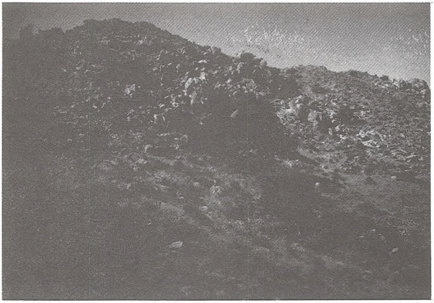


Figure 93. The grass/mixed shrub community in the Little Hatchets is situated on the steep and rocky slopes above 5,000 feet (1,676 m).

History of bighorn occupancy. None of the early chronicles mention the Little Hatchets regarding bighorn sheep. However, several local residents have occasionally observed sheep there. Lewis Lynch saw two rams near the south end of the mountain in the autumn of 1940 (Gordon 1956). About five years ago, Bill Everhart of the Old Hatchet Ranch observed three rams at Hatchet Gap between the Big and Little Hatchet Mountains (Bill Everhart, foreman, Hatchet Ranch, pers. comm., February 16, 1978).

It seems unlikely that the Little Hatchet Mountains were occupied by a resident population of bighorn sheep, at least since the advent of Europeans. This hypothesis seems valid since all historical and related reports mention the Big Hatchets to the south as being the center of bighorn distribution in southwestern New Mexico and since only rams have been observed in the Little Hatchet Mountains. This strongly suggests that the infrequent sheep sightings

in the Little Hatchets were transient rams that crossed over from the Big Hatchets. The two ranges are about two miles apart and are connected by a series of rocky hills, providing easy access. These sheep sightings also correspond to a period of high bighorn densities in the Big Hatchets. The hypothesis is further attested to by the fact that historically only rams have utilized the northern portion of the Big Hatchet Mountains (Mahlon Everhart - owner - Hatchet Ranch, pers. comm., July 31, 1978).

Land status and use. Approximately 67 percent of the area evaluated is public lands administered by the Bureau of Land Management. Eighteen percent of the lands are state owned, 10 percent are patented, and an additional 5 percent are BLM acquired lands (Table 32).

Table 32. Land status in the Little Hatchet Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
BLM	40	25,600	10,360	67
State land	11	7,040	2,849	18
Patented land	6	3,840	1,554	10
BLM acquired land	3	1,920	777	5
Totals	60	38,400	15,540	100

Land use activities include grazing by domestic livestock and mining. The entire mountain, including the steeper topography, is accessible to livestock. Cattle were observed grazing on the summit of Little Hatchet Peak (elevation, 6,585 feet-2,007 m). A mining endeavor is currently being developed at the old Copper Dick Mine on the northern portion of the mountain.

The ghost town of Old Hatchita, nestled in the northeastern portion of the Little Hatchet Mountains, is a tourist attraction. The area receives an estimated 500 visitors per year.

Results. A total of 60 square miles (156 sq km) were qualitatively evaluated in the Little Hatchet Mountains as potential desert bighorn habitat. Fifty-one percent of the area evaluated was classified as a buffer zone, 42 percent as marginal habitat (zone of deficiency), and 7 percent as good habitat for desert bighorn (Table 33 and Figure 95).

Table 33. Evaluation of the Little Hatchet Mountains as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Score	Rating	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	-	-	-	-
51 to 64	Buffer zone	31	19,840	8,029	51
65 to 79	Zone of deficiency (marginal habitat)	25	16,000	6,475	42
80 70 100	Impt. to bighorn (good habitat)	4	2,560	1,036	7
100+	Vital to bighorn (optimum habitat)	-	-	-	--
Totals		60	38,400	15,540	100

Peloncillo Mountains

Study area. The Peloncillo Mountains (a misspelling of piloncillo, meaning sugar loaf in Spanish) are a narrow range rising 1,000 to 1,500 feet (305 to 457 m) above the Animas Valley on the east and the San Simon Valley on the west. They extend north from the border with the Republic of Mexico for some 75 miles (120 km) on both sides of the New Mexico-Arizona line (Figure 96). These mountains are composed of Tertiary volcanic rock (Figure 97) and reach a maximum elevation of 6,467 feet (1,971 m) at Black Point. The more prominent peaks include Guadalupe Mountain (6,450 feet-1,966 m), Mount Baldy (6,300 feet-1,920 m) and Bunk Robinson Peak (6,241 feet-1,902 m).

The mountains are crossed by Interstate 10 at Stein's Pass (4,350 feet-1,326 m), a former station on the Butterfield Stage Line to California; by

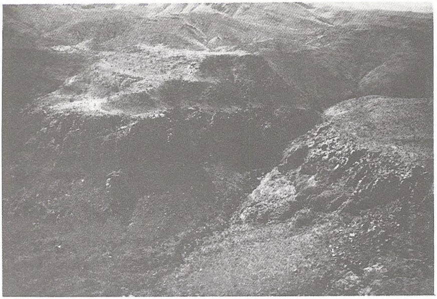


Figure 97. The Peloncillo Mountains are composed of Tertiary volcanic rock and reach a maximum elevation of 6,467 feet (1,971 m).

State Road 9 at Antelope Pass (5,574 feet-1,699 m); and by State Road 338 at Geronimo Gap (5,950 feet-1,813 m) (Figure 96).

Climate. Precise weather data for the Peloncillo Mountains are not available. The nearest weather recording station is at Rodeo (4,118 feet-1,255 m), located along the west side of the mountain range. The average annual precipitation for Rodeo is 10.89 inches (27.6 cm). Sixty-eight percent of the precipitation occurs between July and October. July receives the greatest amount with an average of 2.29 inches (5.8 cm). April receives the least amount with an average of .12 inches (.30 cm) (Figure 98).

The mean annual temperature for Rodeo is 58.9 degrees F. (15.1° C.). January is the coldest month with an average temperature of 43.1 degrees F. (6.2° C.). July is the warmest month with a mean maximum temperature of 79.9 degrees F. (26.8° C.) (Figure 98).

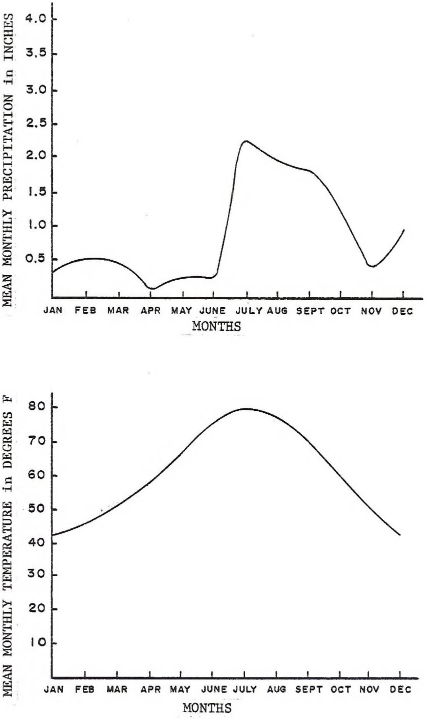


Figure 98. Mean monthly precipitation and temperatures for Rodeo, New Mexico, from 1966 to 1976.

These data probably do not reflect climatic conditions within the southern portion of the mountain range. The southern Peloncillo range contains the higher peaks which intercept precipitation during the winter months as a result of moist Pacific Ocean air which reaches New Mexico in the general circulation from the west. As a result, the southern Peloncillos and the Animas Mountains (8,519 feet-2,596 m) 15 miles (24 m) to the east form a rain shadow. Plant distribution tends to support this theory.

Soils. Soils in the Peloncillo Mountains include the Rock Land-Haplargids association, which are developing in material of igneous origin (Maker *et al.* 1974).

Rock Land is a complex of very shallow soils and outcrops. The bedrock occurs as extensive vertical exposures throughout much of the mountain range (Figure 99). In many parts, a large amount of loose rock occurs on the surface. A thin mantle of cobbly or stony soil material is usually found between the outcrops of bedrock. Although the intermingled soils are dominantly shallow, small areas of moderately deep soils occur as pockets among the rock outcrops.

The Haplargids are usually associated with moderately steep landscapes. These soils usually have thin, moderately coarse and medium textured surface layers over moderately well-developed subsoils. Gravel, cobble, and stones frequently occur in both surface and subsoil layers (Maker *et al.* 1974).

Vegetation. Merriam's Life Zones represented in the mountain include the Lower Sonoran, Upper Sonoran, and Transition. The southern portion of the range is primarily in the Transition Zone. The floristics of this area have a pronounced influence of the Sierra Madres in Mexico. Vegetation is characterized by localized stands of coniferous forest consisting of Arizona pine (*Pinus ponderosa* var. *arizonica*), Chihuahua pine (*Pinus leiophylla* var.

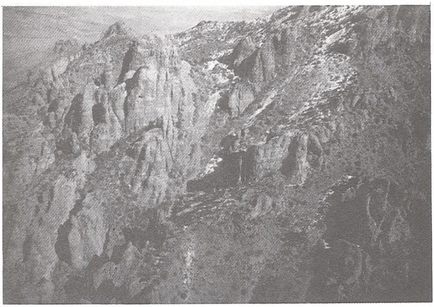


Figure 99. The Rock Land soil association in the Peloncillo Mountains is a complex of very shallow soils and extensive vertical exposures of bedrock.

chihuahuana), Mexican white pine (*Pinus flexilis* var. *reflexa*), Apache pine (*Pinus engelmanni*), and Mexican piñon pine (*Pinus cembroides*). The understory consists of oaks (Silverleaf oak-*Quercus hypoleucoides*, netleaf oak-*Q. reticulata*, Mexican blue oak-*Q. oblongifolia*), mountain mahogany, sacahuista, and various other shrubs. Canopy coverage was estimated at 80 percent, and the relative composition at 60 percent trees, 35 percent shrubs, and 5 percent forbs.

Xeric species indicative of the Sonoran Life Zone replace the coniferous forest in a gradual northern cline and with a loss of elevation. Two general vegetative communities were recognized; a mixed shrub/grass type occupying sites with deeper soils, moderately steep topography, and higher rainfall; and a grass/desert shrub type associated with steep, rocky slopes, shallow soils, and areas usually receiving less than 10 inches (25.4 cm) of precipitation (Figure 100).

The mixed shrub/grass type consists of oak, mountain mahogany, Apache plume, sacahuista, yucca, cactus, muhly, and grama. Vegetative cover was estimated at 40 percent, and the composition at 70 percent shrubs and trees, 25 percent graminoids, and 5 percent forbs.

The grass/desert shrub community is dominated by grama, dropseed, three awn, sacahuista, agave, yucca, and sotol. Vegetative cover was estimated at 25 percent, and the relative botanical composition at 50 percent grasses, 40 percent shrubs, and 10 percent forbs.

A partial list of plants occurring in the Peloncillo Mountains is found in Appendix 32.

Water availability. A total of 36 water sources were located in the Peloncillo Mountains (Appendix 33). The majority of these consist of windmills and earthen stock tanks. Most of the naturally-occurring water sources are found in the extreme southern portion of the mountain range (Figure 100).

History of bighorn occupancy. In 1906, H. H. Hotchkiss told Bailey (1931, page 21) that a few bighorn occurred in the Cloverdale Range (the extreme southern portion of the Peloncillo Mountains). This is the only documented report of sheep in this area, suggesting that they were not particularly common. During the course of fieldwork, Mr. Bob Evans reported that he had seen a single bighorn ram on Gray Peak about eight years ago (Bob Evans - rancher, pers. comm., February 13, 1978).

Land status and use. The U.S. Forest Service administers approximately 31 percent of the area evaluated as potential desert bighorn habitat in the Peloncillo Mountains. Public lands administered by the Bureau of Land Management compose 30 percent, patented lands make up 28 percent, and state lands constitute 8 percent (Table 34).

Table 34. Land status in the Peloncillo Mountains.

Ownership	Area			
	Sq Mi	Acres	Hectares	Percent
U.S. Forest Service	102	65,280	26,418	32
BLM	101	64,640	26,159	30
Patented lands	97	62,080	25,123	28
State lands	29	18,560	7,511	8
BLM acquired lands	8	5,120	2,072	2
BLM administered lands	2	1,280	518	.5
Totals	339	216,960	87,802	99.5

Major land use activities include grazing by livestock and recreation. Grazing is allowed by permit within the Douglas Ranger District-Coronado National Forest. The Douglas District within New Mexico is divided into eight grazing allotments, encompassing 69,772 acres (28,236 ha). Seventy-eight percent of this area is classified by the U.S. Forest Service as suitable for livestock grazing. An average of 16,943 AUM's have been allowed since 1940 on a yearly or pasture rotation basis (Deecken 1978). According to the Forest Service, more efficient cattle utilization is limited by lack of developed water sources, and many existing water sources are in need of repairs. Data for private lands were not obtained, but in general, these areas are grazed yearlong on a rotation basis (Bob Evans - rancher, pers. comm., Feb. 13, 1978).

Recreation values are available in the Peloncillo Mountains to those who like isolated areas and natural desert settings. Guadalupe Canyon, draining a 26-square-mile (65 sq km) area before entering Mexico, provides a breeding and feeding sanctuary for birds rare to the United States. The great species diversity of flora and fauna creates a special interest in this area for botanists and ornithologists alike.

Results. A total of 339 square miles (881 sq km) were evaluated in the Peloncillo Mountains as potential desert bighorn habitat. Sixty-six percent

of the area was classified as marginal habitat, 23 percent as good habitat, and 11 percent as a buffer zone (Table 35 and Figure 101).

Table 35. Evaluation of the Peloncillo Mountains as potential desert bighorn habitat.

Habitat Rating		Available Habitat			
Score	Rating	Sq Mi	Acres	Hectares	Percent
0 to 50	Not impt. to bighorn	-	-	-	-
51 to 64	Buffer zone	38	24,320	9,842	11
65 to 79	Zone of deficiency (marginal habitat)	223	142,720	57,758	65
80 to 100	Impt. to bighorn (good habitat)	77	49,280	19,943	23
100+	Vital to bighorn (optimum habitat)	1	640	259	.3
Totals		339	216,960	87,802	99.3

DISCUSSION

Introduction

Field investigations were conducted in each of the 16 historic or occupied desert bighorn ranges. These investigations were designed to provide an adequate description of the habitat with emphasis on topography, plant communities, forage availability, location of water, and land status and use.

The habitat was qualitatively evaluated using environmental characteristics as well as degree of human use. In addition to evaluating lands, local factors, both existing and potential, that might limit bighorn sheep use were identified. This method classified bighorn habitat and attached a numerical rating based on subjective values assigned to the following components: topography, vegetation, precipitation, evaporation, water availability, and human use. The method provided a qualitative and quantitative evaluation of the suitability of each mountain range as bighorn habitat.

Considering water availability, plant communities, competition (forage, spatial, degree of human use), and present range conditions, great differences exist among the areas investigated. Even though the potential transplant sites are characterized by rugged terrain, not all contain similar climatic regions, nor do they reflect similar floral and faunal developments. Thus, one is inclined to judge the basic capability of each range to meet the life requirements of desert bighorn sheep on a relative basis with the apparent potential of the San Andres Mountains. However, it should be pointed out that the current ecological relationships in the San Andres offer a unique situation. Bighorn management has been enhanced by military control of the San Andres Mountains. Activities known to be detrimental to bighorn such as livestock grazing, mining, and disturbance by the human element have been prohibited. Overemphasizing the San Andres bighorn habitat might result in

erroneous conclusions in discussing the potential of historic ranges for supporting bighorn sheep.

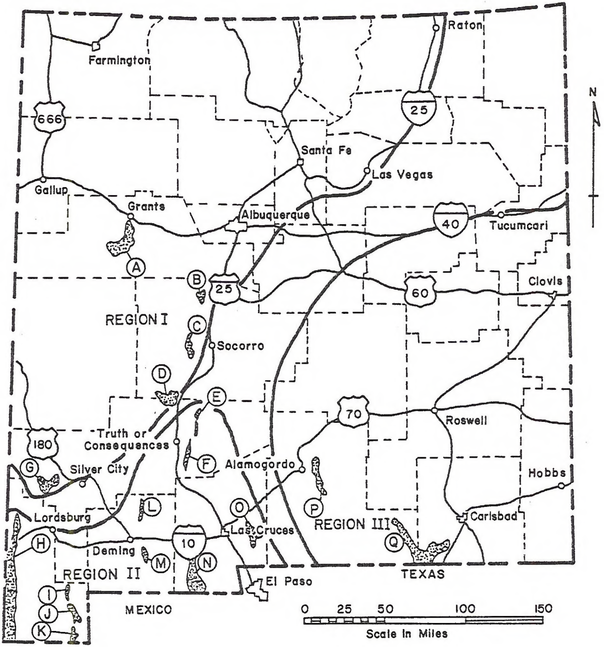
In order to arrive at an objective conclusion as to the relative suitability of the ranges evaluated as bighorn habitat, one must regard each habitat as distinct entities on the underlying concept that we are managing desert bighorn habitat, which means land management and not individual species management.

To facilitate the discussion, the areas evaluated were divided into three general regions (Figure 102). The delineation is based on climatic conditions, distinct floral and faunal components and possible interspecific competition that might seemingly preclude successful reintroductions of desert bighorn.

Region I includes the more mesic, higher elevations of the physiographic area encompassed by the Magdalena, San Mateo, and Ladron Mountains, and the Malpais south of Grants. Region II encompasses the arid, isolated ranges of southcentral and southwest New Mexico west of the Tularosa Basin to include the Fra Cristobal Range, then west extending along the arid south-facing front of the Mogollon Plateau. The third region includes the Sacramento and Guadalupe Mountains on the east side of the Tularosa Basin (Figure 102). Delineation of this region is based on political and esthetical parameters.

Three major criteria were considered in this discussion of the relative suitability of the areas evaluated as potential habitat for desert bighorn:

1. Available habitat - the percent of the total area classified as good to optimum habitat for bighorn sheep.
2. Competition - the possibility of invasion by nonindigenous or conspecific wildlife, and degree of human use.
3. Land status and use - the percent of Federal and State owned lands in the various ranges (Table 36).



LEGEND

A	Malpais Lava Flow	J	Big Hatchet Mtns.
B	Ladron Mtns.	K	Alamo Hueco Mtns.
C	Magdalena Mtns.	L	Cooks Range
D	San Mateo Mtns.	M	Florida Mtns.
E	Fra Cristobal Mtns.	N	West Potrillo Mtns.
F	Caballo Mtns.	O	Organ Mtns.
G	Burro-Gila Middle Box	P	Sacramento West Escarp
H	Peloncillo Mtns.	Q	Guadalupe Mtns.
I	Little Hatchet Mtns.		

Figure 102. Map of New Mexico showing the location of the ranges evaluated as desert bighorn habitat and grouped into three distinct regions.

Table 36. Relative suitability of historic desert bighorn sheep ranges as potential transplant sites.

Area	Size (mi^2)	Available habitat[a]	Competition[b]	Land status[c]
Alamo Hueco Mtns.	66	35	Low	57
Big Hatchet Mtns.	89	27	High (livestock grazing)	99
Burro Mtns.-Gila Middle Box	90	38	High (Rocky Mtn. bighorn)	68
Caballo Mtns.	82	5	High (human use and livestock grazing)	93
Cooke Range	102	14	Moderate (ibex and livestock grazing)	74
Florida Mtns.	44	41	Occupied (ibex)	87
Fra Cristobal Mtns.	61	32	Low	0
Guadalupe Mtns.	182	55	Occupied (aoudads and human use)	95
Ladron Mtns.	54	35	Moderate (feral goats)	65
Little Hatchet Mtns.	60	7	High (livestock grazing and human use)	90
Magdalena Mtns.	146	12	High (human use)	91
Malpais	254	2	Low	35
Peloncillo Mtns.	339	24	Moderate (livestock grazing)	71
Sacramento West Escarpment	101	27	Occupied (aoudads and feral goats)	70
San Mateo Mtns.	29	24	Moderate (human use)	96
West Potrillo Mtns.	134	0	Moderate (ibex)	100

[a] Percent of total area classified good to optimum habitat (refer to Tables 5, 8, 10, 11, 12, 14, 15, 17, 18, 20, 22, 24, 26, 29, 33, and 35).

[b] Competition includes degree of human use and the possibility of invasion by nonindigenous or conspecific wildlife. Nonindigenous wildlife includes aoudads, ibex and feral goats, conspecific includes Rocky Mountain bighorn sheep (see discussion).

[c] Percent of total area administered as Public or State Lands (refer to Tables 4, 7, 9, 13, 16, 19, 21, 23, 25, 28, 32, and 34).

Region I - Mesic Mountainous Region

The Mesic Mountainous Region is mostly in the Colorado Plateau physiographic province but a part of the southern section is in the Basin and Range province. Most of this area consists of forested mountains, isolated volcanic peaks, and lava flow. Elevation ranges from 5,000 to 11,000 feet (1,524 to 3,353 m).

The climate is semiarid to subhumid. Winters are rather cold; summers are warm; and days are sunny. Precipitation generally increases with elevation. In most of the region, slightly more than half of the annual precipitation comes in summer, in brief afternoon and evening thundershowers. Snowfall is common, averaging from about 15 to 40 inches (38 to 102 cm) per year. Daily temperatures vary by 30 to 40 degrees. Temperatures over 90 degrees F. (32° D.) are uncommon.

There is a great diversity of geological formations in this region. The basaltic and andesitic flows, and the Gila conglomerate, all of Quarternary and Tertiary age, cover most of the area.

San Mateo Mountains. Twenty-four percent of the area evaluated in the San Mateo Mountains was classified as suitable habitat for bighorn sheep. Throughout much of the area many cliffs and rocky areas exist, but arborescent vegetation crowds them so closely that insufficient open range occurs except on the arid south-facing slopes. The mountain range is vegetated by extensive stands of mixed coniferous forest on protected slopes. Exposed slopes are vegetated by a dense mountain shrub community, while extensive grassland types characterize the piedmont. The potential bighorn habitat is situated at higher elevations among the cliffs and talus slopes, the south-facing benches along the piedmont, and in San Mateo Canyon on the southwest portion of the mountain range.

Magdalena Mountains. Twelve percent of the area evaluated in the Magdalena Mountains was classified as suitable habitat for bighorn sheep. The mountain range features an oak-shrub/piñon juniper community at lower elevations and a mixed coniferous forest at higher elevations. Interrupting this subalpine forest are herb-dominated meadows where floristics contrast sharply with adjacent forest communities.

The Magdalena subalpine region is today far isolated from its nearest subalpine region, thus the high-elevation forests and adjacent herbaceous communities are insular in character and have probably been isolated from contiguous subalpine distribution for at least 12,000 years (Martin and Mehringer 1965). The occurrence of subalpine communities in these mountains and their long isolations are important factors in the ecological and taxonomic interpretation of this region.

Malpais. Sixty-eight percent of the area evaluated in the Malpais was classified as marginal habitat. Factors considered limiting the suitability of the lava flow as desert bighorn habitat were the vegetative structure and lack of available water.

The parent material of the Malpais is recent, thus soils are poorly developed. Vegetation is sparse and lacks species diversity. The less than optimum interspersion of shrubs, forbs, and grasses would probably limit bighorn use, since sheep are specialized feeders, requiring seasonal availability of palatable and usable forage. Water is restricted to seasonal potholes and windmills along the periphery of the lava flow.

The poor juxtaposition of palatable forage, open areas providing good visibility, and water would probably create an environment unsuitable for continued occupancy by desert bighorn in the Malpais.

Ladron Mountains. Thirty-five percent of the area evaluated in the

Ladron Mountains was classified as good to optimum habitat for bighorn sheep. In addition to the availability of suitable habitat for bighorn, an important aspect of the current ecological relationship in the Ladron Mountains is an unfilled big game habitat, especially on the upper reaches. The mule deer population was estimated at between 2.3 ± 1.3 deer per section by Sutcliffe (1972). This figure compares favorably with 2.7 deer per section estimated by the Bureau of Land Management. Based on 2.5 deer per section, the current estimated deer population inhabiting the entire mountain is 135. Actual deer numbers are probably much lower, as only a single unclassified deer was observed during the course of field work. The upper mountain (above 7,000 feet-2,134 m) appears to receive little or no utilization by deer, probably due to the precipitous topography which could limit the overall suitability of the area as deer habitat.

Access to the potential bighorn habitat would be confined to walking as most of the mountain is inaccessible to horses. There are no permanent habitations on the mountain. Three small ranch houses near the foothills are occasionally occupied by cattlemen. Human visitation would probably be heaviest during the hunting season.

The possibility exists of a herd of feral goats inhabiting the northeast flank of the mountain. Two fresh, partially-consumed goat carcasses were located during the course of field work within Cañon del Alamito (NE¼ of the SE¼, S-29, T3N, R2W). Fecal pellets and beds were located within a small cave on the south side of Cañon del Alamito. Deer have never been observed to use caves as bedding grounds.

The Ladron Mountains were apparently never inhabited by either desert or Rocky Mountain bighorn. Nevertheless, the lack of historical bighorn occupancy should not be the major criterion in determining the suitability of an

area for perpetuating a bighorn population.

The small, rugged mountain ranges typical of bighorn habitat are discontinuous and separated by natural barriers, such as large, flat expanses of desert or forested areas. Consequently, a number of these ranges were apparently never colonized during the Pleistocene when bighorn spread throughout the Northern Hemisphere.

Conclusions on the Mesic Mountainous Region

The evaluation of the Magdalena, Ladron, and San Mateo Mountains indicated that the potential bighorn habitat encompasses several life zones. Considering the distribution of desert bighorn sheep today, available data suggest that the species appears to maintain higher qualitative and quantitative population levels in habitats that extend from the Lower Sonoran to Hudsonian and Subalpine Life Zones. Some of the largest concentrations of desert bighorn found today occur on these ranges that extend from the desert floor through three or more life zones. The Sheep Range in Nevada and the San Gabriel Mountains of California are two good examples. The Sheep Range with 208 square miles (614 sq km) of suitable sheep habitat supports more bighorn than the combined totals of the Kofa, Cabeza Prieta, and the San Andres Refuge that are all in lower life zones (Deming 1962, McQuivey 1978).

Region II - Warm Desertic Region

The Warm Desertic Region occupies the southwestern part of the state, within the Basin and Range province. Steep and rugged desert mountain range and isolated peaks rise abruptly from the desert floor. The mountain ranges, which trend from north to south, are not continuous for long distances. Elevations range from 4,000 to 5,000 feet (1,219 to 1,524 m) in the basins and valleys to over 9,000 feet (2,743 m) on some of the higher peaks. The

potential bighorn habitat is discontinuous and separated by natural barriers, such as flat expanses of desert.

The climate is of the arid continental type characterized by low rainfall, warm summers, and mild winters. Annual precipitation averages about 10 inches (25.4 cm). Somewhat over half of the precipitation falls in summer. Snow occurs a few times each winter but usually disappears within a day. Evaporation amounts to about 90 inches (229 cm) per year. The mean annual temperature is about 61 degrees F. (16° C.).

The geology consists of Tertiary sedimentary fault blocks, separated by grabens of Quaternary age. In the extreme southwestern corner of the state, the mountains are Tertiary igneous rock. Numerous cinder cones of early Tertiary age dot the landscape southwest of Las Cruces.

Big Hatchet Mountains. Twenty-seven percent of the area evaluated in the Big Hatchet Mountains was classified as good to optimum habitat for desert bighorn. This evaluation indicated that the areas receiving the heaviest utilization by bighorn is marginal habitat. Factors considered as limiting the overall suitability of the southern portion of the mountain range were 1) the relative gentle topography lacks adequate escape terrain to provide cover, concealment, and lambing grounds for the bighorn, 2) the subdued terrain renders the majority of the area accessible to livestock grazing, and 3) vegetative communities are relatively homogeneous, lacking species diversity when compared to the northern portion of the mountain.

Apparently the Big Hatchet bighorn as a remnant herd are withdrawn into what for them is the most desirable portion of their former range; therefore, we are faced with a paradox. Why would the sheep prefer the least desirable portion of the available habitat, as we see it? To answer this question, some assumptions must be made, 1) bighorn sheep experts do not know enough on what

constitutes good bighorn habitat, 2) the southern portion of the mountain is indeed good habitat, and 3) habitat utilization by this population is largely determined by tradition.

Notwithstanding that unknowns do exist in reference to bighorn habitat, we do know that four factors are basic to bighorn: food, water, escape terrain, and living space. Considering the various habitats currently occupied by desert bighorn sheep, it appears that one of the most important components is rugged, broken topography with sufficient open areas to provide good visibility. The need for rock outcropping, precipitous cliffs, and generally rough topographic features as part of the physical habitat of bighorn is well-known and hardly requires comment. However, less well-understood is the degree to which juxtaposition and less than optimum interspersion of these features renders a particular range as marginal habitat, and the influence that social behavior has on habitat selection.

The second assumption states that the southern portion of the mountain range is indeed good bighorn habitat. However, the precarious state of this remnant population and its apparent inability to at least partially recover casts some doubt on this assumption.

The high lamb mortality attributed to predation is considered to be the major decimating factor depressing the population. This evaluation indicated that preferred habitats lack adequate escape terrain to provide cover and concealment and that vegetative communities lack species diversity when compared to the northern portion of the mountain. Therefore, the second assumption will also be rejected.

The Big Hatchet bighorn are utilizing the less precipitous and hence most accessible portion of the mountain range. Habitat use by bighorn sheep is determined to a large extent by tradition. Bighorn are highly social animals

which use the same range year after year. Home range knowledge is inherited by young sheep from their parents through learning behavior. Unlike many species, bighorn, especially ewes, do not appear to explore and colonize new territory, but rather seem content to live as their ancestors have in the past. This is evident in the Big Hatchet Mountains. Therefore, the assumption that habitat use is determined largely by tradition most probably describes the current situation in the Big Hatchet Mountains.

Alamo Hueco Mountains. Thirty-five percent of the area evaluated in the Alamo Hueco Mountains was classified as good to optimum habitat for desert bighorn. The areas that appear to be most suitable for desert bighorn are situated along the northwest, north, and east flanks. This area contains an abundance of open, well-vegetated areas in close proximity to steep and rocky terrain.

A distinctive feature of the Alamo Hueco Mountains is the extensive areas covered by a perennial grassland vegetation type. A mixed shrub/grass type is found within canyon bottoms, on adjacent protected slopes, and below outcrops of rocks. The less than optimum interspersion of shrubs, forbs, and grasses within the homogeneous grassland community might limit bighorn use, since sheep are highly specialized feeders, requiring seasonal availability of palatable and usable forage. Critical periods would be during the winter months when grasses have matured and are less palatable, and during drought when grasses and forbs are not available.

Twenty-one water sources were located within and adjacent to the mountain range. The majority of these sources consist of manmade structures in close proximity to escape terrain, therefore, the accessibility to watering places would be satisfactory for bighorn and should adequately serve their needs.

Approximately 54 percent of the area evaluated as potential desert bighorn habitat is administered as public lands by the Bureau of Land Management.

Pacific Land and Cattle Company, a subsidiary of Phelps-Dodge Corporation, owns about 43 percent, which is known as the U-Bar Ranch. Pacific Land and Cattle Company has restricted all public access and has also reduced grazing by livestock in the Alamo Hueco Mountains.

Peloncillo Mountains. Twenty-three percent of the area evaluated in the Peloncillo Mountains was classified as good habitat for desert bighorn sheep. The area that appears to be most suitable for bighorn is located between Burro Pass north to Granite Gap, along the west-facing slope of the mountain range. The southern portion of the mountain range was classified as unsuitable for bighorn. Throughout this area, many cliffs and rock outcrops exist, but arborescent vegetation crowds them so closely that insufficient open areas occur except on the arid south-facing slopes.

A total of 36 water sources were located in the Peloncillo Mountains. These sources consist mainly of windmills and earthen stock tanks. The few naturally-occurring springs and seeps are situated in the relatively mesic southern portion of the range.

Sixty-one percent of the area evaluated is public lands administered by either the U.S. Forest Service or the Bureau of Land Management. However, a very small percentage of the suitable bighorn habitat is within the National Forest. The majority of the potential habitat is situated in Bureau of Land Management and patented lands.

Within the areas that appear to be suitable for bighorn, the habitat is frequently bisected by low, wide gaps that traverse the entire width of the mountain range. The discontinuous nature of the areas that appear most suitable might limit bighorn expansion. Bighorn distribution may also be directly affected by limited water availability.

Fra Cristobal Mountains. Thirty-two percent of the Fra Cristobal

Mountains was classified as good habitat for desert bighorn. The most suitable bighorn habitat is located in the northern geographic unit. Escape terrain is found among limestone cliffs along the west escarpment and in the east-dipping slope which is deeply bisected by numerous small drainages. Two general plant communities are found on adjacent steep and rocky slopes; a desert shrub/grass type on exposed slopes and a low shrub/grass type on protected slopes.

The juxtaposition of water, palatable forage, and escape terrain, were found to be the major factors limiting the suitability of the Fra Cristobal Range for desert bighorn. All five of the existing water sources are located within one square mile (2.6 sq km). In addition, these sources are in relatively gentle topography, approximately four to six miles (6.4 to 9.6 km) from what appears to be the most suitable area for desert bighorn. Therefore, the accessibility to water places would probably not be satisfactory for bighorn sheep.

Cooke Range. Ten percent of the area evaluated in the Cooke Range was classified as suitable for bighorn sheep. Water was found to be adequate. Numerous springs and seeps are located high on the mountain within the major drainages. An important aspect of the current ecological relationships in the Cooke Range is unfilled big game habitat, especially on the upper reaches. The potential desert bighorn habitat is found on the arid south-facing slopes in the vicinity of Cooke's Peak and Rattlesnake Ridge.

The biggest factor limiting the Cooke Range as desert bighorn habitat is the poor interspersion of open feeding areas, escape terrain, and water. Much of the mountain range is vegetated by a dense mountain shrub-piñon-juniper community with a canopy coverage of 80 to 100 percent.

Little Hatchet Mountains. Seven percent of the area evaluated in the

Little Hatchet Mountains was classified as good habitat. Factors limiting the suitability of the Little Hatchets as desert bighorn habitat include the relatively gentle topography, degree of human use and small size.

The mountain lacks extensive precipitous terrain, even though the vegetative structure appeared to be adequate. Escape cover is limited to localized outcrops of limestone mainly along the higher ridges, therefore it was considered to be inadequate for bighorn. Human use includes livestock grazing and mining. Approximately 80 percent of the mountain range is accessible to livestock. Cattle were observed grazing on the summit of Little Hatchet Peak, the highest point on the mountain. A mining endeavor is currently being developed at the old Copper Dick Mine on the northeast end of the mountain range.

Burro Mountains-Gila Middle Box. Forty-two percent of the area evaluated was classified as suitable and 43 percent as marginal habitat for bighorn sheep. Less than optimum juxtaposition of available and palatable forage, open areas providing good visibility and the proximity of rough topographic features were considered the major habitat factors limiting the suitability of the Burro Mountains-Gila Middle Box. This discontinuous nature of the representative sheep habitat would probably restrict sheep use to small isolated pockets of suitable habitat.

The close proximity of this area to occupied Rocky Mountain bighorn (*O. c. canadensis*) habitat should be an important consideration before releasing desert bighorn. A Rocky Mountain bighorn ram was observed about five years ago outside the sheep enclosure at Red Rock (Walt Snyder, pers. comm., April 4, 1978). More recently, sheep were sighted at Black Mountain located 10 miles (16 km) north of the Burro Mountains (I. Dinwiddle, pers. comm., April 18, 1978). The possibility exists that these were Mouflon sheep (*O. musimon*), as these exotics have been released at the Moon Ranch, east of Black Mountain

(Byron Donaldson, pers. comm., April 4, 1978). Mouflons have recently been reported along U.S. Highway 180 north of Cliff.

Caballo Mountains. Five percent of the area evaluated in the Caballo Mountains was classified as good habitat for desert bighorn. East slopes, characterized by relatively gentle topography and a dense piñon-juniper woodland, would probably restrict bighorn use to a narrow belt of cliffs along the west-facing escarpment. Even though topographic features and vegetative communities on west slopes were found to be suitable for desert bighorn, the high degree of human use, and the lack of water would probably preclude successful introduction of bighorn. Naturally-occurring water was found to be non-existent within the mountain. Water sources, consisting of windmills and stock tanks, are found in the periphery of the mountain. Heavy livestock use was evident at most of these sources. Other man use activities include several mining endeavors. Two operational mines are located in the alluvium at the base of the west escarpment and a third is located on the summit.

Organ Mountains. Limited field work was conducted in the Organ Mountains. Due to military restrictions, only limited access was allowed, consequently an objective evaluation of these mountains was not possible. Negotiations with military authorities will continue for clearance into this area to ascertain the presence of bighorn sheep.

The possibility exists of a small remnant herd of bighorn in these mountains. Both factual and circumstantial evidence support this theory. The Organs are historic sheep range, consisting of an extremely rugged series of spires and pinnacles. Only with organized effort over a period of several days could an idea of numbers be obtained. The U.S. Fish and Wildlife Service, in the fall of 1952 and again in August 1958, surveyed this area. The 1952 survey resulted in the observation of eight bighorn in the vicinity of Baylor Peak in

the northern portion of the mountain. The 1958 survey produced a total of 14 sheep on the south side of Soledad Canyon. The fact that small lambs were present in these sightings suggests that these were resident herds.

West Potrillo Mountains. Fifty-five percent of the area evaluated in the West Potrillo Mountains was classified as not important for bighorn, while 45 percent was classified as a buffer zone. The homogeneity of the vegetative communities, lack of water, and the gentle topography were considered as the major factors limiting the suitability of the West Potrillo Mountains for desert bighorn.

Much of the range is vegetated by a desert shrub type lacking species diversity. The poor interspersion of shrubs, grasses, and forbs would probably create an environment unsuitable for continued occupancy by bighorn. Mountain sheep are some of the most specialized feeders, requiring a good interspersion of grasses, browse, and forbs. Escape terrain was considered to be inadequate for the bighorns' daily and seasonal life activities. Free water was found to be non-existent within the mountain. Water sources are located from .5 to 4 miles (.8 to 6.4 km) from the mountain range. These sourses consist of windmills or earthen stock tanks that retain water seasonally and are usually enclosed within a corral and receive frequent livestock use.

A multi-million dollar gas refinery that would pump Alaskan crude oil from the west coast to west Texas is currently being considered for southern New Mexico. This refinery would be located in the vicinity of the West Potrillos. These mountains have been considered for wilderness designation, and are currently rated as a good potential.

Florida Mountains. Forty-one percent of the area evaluated in the Florida Mountains was classified as good to optimum habitat for desert bighorn.

Possible competition between ibex and desert bighorn would be the major

criterion for determining the suitability of the Florida Mountains as a release site for bighorn. Since the initial release of 42 Persian ibex (Capra aegragus) in these mountains in 1970, the population has steadily increased to a currently-estimated 200 animals.

Studies of food habits of ibex in these mountains indicate that mountain mahogany constitutes 53 percent relative density of the diet, while this same species composed 43 percent relative density of the desert bighorn diet in the San Andres Mountains. These data suggest that competition for food resources between ibex and bighorn could be expected and since both species show a preference for steep, highly-bisected terrain with numerous cliffs and deep canyons, spatial competition might also be expected.

Region III - Sacramento and Guadalupe Mountains

This region encompasses the Sacramento and Guadalupe Mountains on the east side of the Tularosa Basin. The two ranges are discontinuous, being separated by a wide gap south of the community of Piñon. They extend north and south for over 150 miles (240 km). Elevations range from 4,000 to 9,000 feet (1,219 to 2,713 m). The potential bighorn habitat is situated along a series of west-facing cliffs and in the southeast escarpment and rugged canyons of the Guadalupe Mountains.

The climate is semiarid, continental type characterized by low rainfall, warm summers, and mild winters. The deep canyons throughout this region contain more surface water than the desertic ranges of southwestern New Mexico. This abundance may be a reflection of local weather conditions. These mountains have a shielding effect on the southeastern airflow from the Gulf of Mexico. Consequently, the amount of warm-season precipitation received west of the Tularosa Basin is lower than to the east. This pattern yields a higher

potential of free water production during the critical spring and early summer months. Temperatures, however, appear to be similar with those of southwestern New Mexico.

The geology consists of Tertiary sedimentary faulted bedrock and an extensive fossil reef complex of Permian age.

Sacramento Mountains. Twenty-six percent of the area evaluated in the Sacramento Mountains was classified as good to optimum habitat for desert bighorn.

Factors limiting the suitability of the Sacramento Mountains as potential bighorn habitat are the vegetative structure, less than optimum distribution of available water, the homogeneity of the available escape terrain, and possible interspecific competition with aoudads and feral goats.

A group of aoudads has repeatedly been sighted in Fresnal Canyon. At least three established populations have reportedly been located in the rugged terrain of the Sacramento Mountains. In addition to aoudads, a significant number of feral goats occupies the west escarpment. Mike Bodenchuck, a wildlife student at New Mexico State University currently studying these goats, estimates that between 150 and 200 occupy the area.

The potential bighorn habitat in the Sacramento Mountains appears to be more Upper Sonoran with a trend toward the Transition on north exposures and at higher elevations; therefore, the representative habitat is confined to a relatively narrow belt of cliffs along the west-facing escarpments. Within the cliff habitat type, the areas that appear to be suitable for bighorn are repeatedly broken by side canyons which represent areas decidedly dissimilar in vegetative composition and density. This discontinuity of the most desirable habitat may represent an environment not conducive to continued occupancy by desert bighorn. Bighorn may travel or utilize, to a limited

extent, a biotic community which does not necessarily meet the requirements of a home range.

Additional habitat-related factors limiting the suitability of the Sacramento Mountains for bighorn are the less than optimum distribution of available water and the homogeneity of the available escape terrain. Few naturally-occurring water sources are found in the potential sheep habitat. Large expanses of the cliff habitat type are characterized by vertical outcrops of limestone forming a massive cliff in places exceeding 500 feet (152 m) high, therefore rendering the cliffs inaccessible even to bighorn. Rough topography in itself is not necessarily a criterion of good bighorn habitat, there must also be well-interspersed and usable habitat components.

Guadalupe Mountains. Fifty-five percent of the area evaluated in the Guadalupe Mountains was classified as good to optimum habitat for desert bighorn, while five percent was considered not important for bighorn.

Ninety percent of the acreage considered as not important to bighorn, and 78 percent classified as a buffer zone occurred along the West Rim. Factors limiting the West Rim as sheep habitat include the high degree of human use, lack of water in open areas and in close proximity to escape terrain, the relatively homogeneous topography, and the apparent wide distribution of aoudads.

The entire summit of the West Rim is readily accessible by automobile. The U.S. Forest Service recently completed an all-weather road south along the rim to within four miles (6.4 km) of the Texas state line. State Road 137 from Carlsbad to El Paso which traverses the West Rim has recently been surveyed for paving.

Only one naturally-occurring water source (Devils Den Spring, NW¼ of the NE¼, S-21, T-26S, R-21E) was located along the 30 miles (48 km) of the rim

that were evaluated. This spring is located in a deep, timbered canyon. The few water sources along the West Rim are earthen stock tanks located in the foothills within Big Dog Canyon, and in the east-dipping slope of the summit which is characterized by a piñon-juniper woodland.

The topography along the rim is relatively unbroken. The potential bighorn habitat is confined to a narrow belt of cliffs occurring as a series of outcrops of horizontally-layered limestone. With the exception of approximately 15 square miles (39 sq km) in Little Dog and Pup Canyons, escape terrain was considered to be inadequate for bighorn.

The precipitous southeast-facing escarpment, frequently bisected by numerous deep canyons, was considered to be suitable bighorn habitat. Numerous springs, seeps and intermittent streams are found within the major drainages in close proximity to escape terrain, therefore the accessibility to watering places could be satisfactory for bighorn and should adequately serve their needs.

Of the total area classified good to optimum in the Guadalupe Mountains, 77 percent is found along the southeast escarpment. Fifty-four percent of the area classified as vital to bighorn is within Carlsbad Caverns National Park. If the objective is to re-establish huntable populations of desert bighorn sheep, national park policy would conflict with this objective. However, if the objective is to promote viable populations of indigenous wildlife species, national park lands could serve as a center of distribution and a hub for dispersal.

The National Park Administrative policy has changed somewhat from the passive "hands-off" attitude to an active and directive form. Obviously, additional work is necessary, and increased emphasis must be placed upon the management phases of wildlife programs.

An important fact regarding concepts of wildlife management in the Park Service is the accomplishment of management for the welfare of all species of indigenous wildlife, including habitat manipulation, and animal population controls. This concept is being planned in individual area master plans (Blaisdell 1966).

The major factor limiting the Guadalupe Mountains as a potential release site for desert bighorn is the apparent wide distribution of aoudads. Five sheep beds and several sets of tracks (presumably aoudad) were located on the north side of North McKittrick Canyon, as were trails along a talus slope in Double Canyon. Numerous sheep beds and tracks were also located in Little Dog Canyon along the West Rim. Fourteen aoudads were observed by Forest Service personnel in August 1977. National Park Service personnel have observed aoudads in West Slaughter Canyon, Carlsbad Caverns National Park, and aoudads have been killed in Guadalupe Mountains National Park, Texas (D. Birdwell, pers. comm., Oct. 10, 1977).

The objective is not to discuss the pros and cons of the desirability of exotics, or to argue if they belong here or not. They're already here. The question at hand is: to what degree is the aoudad able to compete with the desert bighorn? For competition with our native sheep to occur, the aoudad must: 1) be in a similar geographic area as the bighorn, 2) prefer the same habitat as the bighorn, and 3) be able to utilize the habitat as well as or better than the bighorn.

One of the justifications for releasing exotics was that their numbers could be controlled or even eradicated if a threat to indigenous wildlife would occur. The difficulty and expense of obtaining and successfully rearing desert bighorn dictate that they are simply too valuable to risk in any manner, even though the risk in terms of competition might be controlled to

some extent. The present distribution of aoudads has already encompassed suitable desert bighorn habitat in the Guadalupe, Sacramento and San Andres Mountains. If the aoudad should ever gain foothold in the Guadalupe and San Andres Mountains, it would be extremely costly or even impossible task to remove them. Hence, prime bighorn habitat would be permanently lost to the already-beleaguered desert bighorn. Although aoudads are presently sympatric with mule deer and Siberian ibex (Capra siberica Meyer) in New Mexico, the greatest potential danger of competitive exclusion lies with its nearest ecological counterpart, the desert bighorn.

Comparing the evolutionary history, preferred habitat, food habits and reproductive potential of aoudads and desert bighorn, the former has had up to three times as long to evolve desert adaptations, and should therefore be better adapted to desert environments than is the bighorn. The rapid dispersal and less-selective colonization of virtually any rough terrain by aoudads suggests an ecologically more aggressive species. We can also conclude from the available literature that the aoudad and the desert bighorn would be in direct competition for available food resources if placed in the same habitat. Data are also available indicating that aoudads could outproduce our native sheep, since these exotics produce at an earlier age and have more young per year than bighorn sheep (Barrett 1967, Simpson 1978).

Simpson (1978) estimated a population of 550 aoudads between the Hondo Valley in New Mexico and the Texas state line in December 1977. He further stated that this population is apparently still in the active dispersal stage as there are many isolated reports of one to five animals throughout the Guadalupe and Sacramento Mountains.

Conclusions on the Sacramento and Guadalupe Mountains

Even though habitat conditions in the Guadalupe Mountains appear to be satisfactory for desert bighorn, the current ecological relationship would probably preclude the successful reintroduction and perpetuation of a population of bighorn sheep.

In addition, the close proximity of this area to the Texas state line, Carlsbad Caverns National Park and Guadalupe Mountains National Park would dictate that any bighorn sheep releases be a cooperative effort between the New Mexico Department of Game and Fish, Texas Parks and Wildlife Department, and the National Park Service.

CONCLUSIONS

New Mexico, with an area of 121,666 square miles (315,115 sq km), has a diversity of climates, soils, vegetation, geologic materials, and topography. Where the low, arid Chihuahuan Desert meets the lofty, forested mountains of New Mexico, a great variety of both plant and animal life has evolved. The distribution of plant and animal life is not wholly dependent upon the interaction of the various factors, but also includes man and land use activities.

Considering climatic conditions and habitat characteristics in the physiographic region of the State encompassed by the Mogollon plateau, Magdalena-San Mateo Mountains, the Malpais, and the Sandia-Manzano complex, it seems quite probable that mexicana and canadensis intergraded in this region.

Two primary criteria tend to support this hypothesis; 1) the present distribution of wild sheep in western North America, and 2) the habitat characteristics and climatic conditions of the regions where the two geographic races have persisted, i.e. the relationship of this physiographic region in New Mexico to the known historical range of mexicana to the south and canadensis to the north. To date, it has never been established which subspecies historically occupied this region and it is likely that the situation never will be clarified because of the lack of skulls and additional records of sightings.

Since the majority of the ranges investigated are relatively isolated and are less influenced by man than more accessible areas, the impact and degree of human use in general is probably less now than during the self-subsistence economy of rural western North America during the 18th century. This period corresponds to the demise of numerous wildlife species, bighorn sheep in particular.

Major detrimental activities such as mining, prospecting, and related

human disturbance in most of the areas are seemingly less now. This is attested to by the numerous scars, dump tailings, abandoned mining camps, and delapidated homesteads located in prime bighorn habitat. These mining camps and homesteads were usually situated near water sources, in most instances, the only water available for the bighorn.

Overgrazing by livestock, however, is still a problem on some of the areas evaluated. One difficulty in trying to put the problem in perspective is the fact that much of the damage done to bighorn ranges by livestock occurred long ago. Secondly, overgrazing in general and its contribution to degraded bighorn ranges is more difficult to demonstrate convincingly than the effects of disease, poaching, and human encroachment.

Overgrazing has been recognized by many as one of the more important factors in the early decline of populations of desert bighorn. There is evidence that overgrazing, and perhaps even the mere presence of cattle in desert bighorn ranges, continues to be a major reason for continuing declines of some desert sheep populations and for the failure of others to increase. The decline of the Hatchet bighorn population can be attributed to competition with cattle and deer in an already-depleted range. Buechner (1960:54), in his excellent monograph on bighorn sheep in the United States, referred to the Big Hatchets and stated: "The keenest competition bighorn sheep presently encounter from cattle is in the Big Hatchet Mountains." Likewise, the extirpation of the Guadalupe bighorn population can be attributed to intensive husbandry of domestic sheep and goats in the most desirable bighorn habitat.

Overgrazing has not ceased, it merely has decreased in intensity. In addition to cattle being a problem for the bighorn threatened with extinction in the Big Hatchets, overgrazed ranges will also be a major obstacle to successful transplants of desert bighorn sheep. If desert bighorn sheep are

to continue as an important, viable component of our desert ecosystem, the Department of Game and Fish must take a firm stand regarding the livestock problem. It is the responsibility of the Department to manage the public/wildlife interface with flexibility so long as the viability of the wildlife populations within the various ecosystems of the State is assured. Bighorn will continue to face a precarious future unless the Department demands that livestock numbers be sharply reduced in the Big Hatchets and in historic habitats to allow range recovery to the point where a reintroduction of bighorn can be made with some hope for success.

RECOMMENDATIONS

1. The Burro Mountains-Gila Middle Box should not be considered as a primary release site for desert bighorn due to this area's close proximity to occupied Rocky Mountain bighorn habitat. Rocky Mountain bighorn have been observed twice in this area. The highly dissimilar vegetative composition between exposed east-facing and protected west-facing aspects produces an intergrade whereby canadensis might utilize the potential habitat more efficiently. Apparently the life requirements of Rocky Mountain bighorn are met by various habitats under a comparatively wide range of environmental conditions, as attested to by the viable population occupying the San Francisco River cliffs.

2. The initial release of desert bighorn should be in the Big Hatchet Mountains. This action is prompted by the rapidly-declining numbers of bighorn which have reached a delicate balance between survival and extirpation. And secondly, immediate action is also necessary in the management of the captive herd at Red Rock. The decline in productivity of this herd could possibly be detrimental effects of crowding conditions or disease within the enclosure.

The objective should be to establish a new population in what appears to be the most suitable part of the available habitat in the Hatchets. In addition to making better use of the available habitat, establishing a new population has other advantages. Current data suggest that inbreeding has probably occurred in this population. Transplanted bighorn would supplement the existing gene pool and enhance population quality. Additional sheep in the Hatchets should alleviate the remnant herd's apparent inability to overcome the threshold between survival and extinction thus insuring the existence of this population.

3. Subsequent releases of desert bighorn should be restricted to the désertic region of southwest New Mexico and the mesic mountainous region

encompassed by the San Mateo, Magdalena, Ladron Mountains and Malpais. Pending management strategies for the aoudad and feral goat populations occupying the Guadalupe and Sacramento Mountains, releases could be attempted east of the Tularosa Basin.

4. Desert bighorn releases should not be attempted in the Guadalupe and Sacramento Mountains before addressing the apparent wide distribution of aoudads in this area. A comprehensive management plan is critically needed, establishing management priorities for indigenous and non-indigenous wildlife. The Department of Game and Fish should not consider any action that would seemingly threaten the viability of New Mexico's indigenous wildlife. Our first responsibility is to maintain or promote viable populations of indigenous wildlife and their habitats.

5. Based on the availability of suitable habitat, minimal disturbance by the human element, and the remote possibility of invasion by exotics, the following ranges are recommended for intensive studies to determine their full potential for perpetuating viable populations of desert bighorn sheep:

Range	Time Schedule
a. Alamo Hueco Mountains	1979-1980
b. Peloncillo Mountains	1979-1980
c. Fra Cristobal Mountains	1980-1981
d. Ladron Mountains	1980-1981
e. San Mateo Mountains	1981-1982
f. Cooke Range	1981-1982

6. Data should be gathered quantatively in order that an objective, comprehensive analysis may be made with respect to these areas' potential as desert bighorn habitat. Specific data should include existing factors which must be modified or developments that must be made before establishment of bighorn

can be expected, and the number of sheep that can be supported. Suitability for desert bighorn should be based on statistical correlations with data developed during the studies of the indigenous bighorn sheep populations in the San Andres and Big Hatchet Mountains.

Literature Cited

Bailey, V. 1905. Biological survey of Texas. USDA Bur. Biol. Surv. North American Fauna 25., 222 pp.

Bailey, V. 1928. Animal life of the Carlsbad Caverns. Monographs of the American Society of Mammologist, No. 3. Williams-Wilkins Co., Baltimore, Md.

Bailey, V. 1931. Mammals of New Mexico. N. Amer. Fauna No. 53., 412 pp.

Barrett, R. H. 1967. Some comparisons between the Barbary sheep and the desert bighorn. Trans. Desert Bighorn Council 11:16-26.

Bavin, R. L. 1975. Ecology and behavior of the Persian ibex in the Florida Mountains, New Mexico. M.S. Thesis, Colo. St. Univ., Ft. Collins. 141 pp.

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present and future. Wildl. Mono. No. 4. The Wildlife Society. 174 pp.

Bureau of Land Management. 1975. Environmental analysis record. Proposed release of Siberian ibex, Ladron Mountains, New Mexico. 124 pp.

Deecken, T. 1978. Grazing history of the Peloncillo Mountains, New Mexico. Typed letter to Andrew Sandoval. N. Mex. Dept. Game and Fish files, Las Cruces.

DeLorenzo, D. G. 1974. Analysis of vegetation of the Game-Coin enclosure and food habits of Mexican bighorn sheep of Red Rock, New Mexico. M.S. Thesis, N. Mex. St. Univ. 43 pp.

Foster, R. W. 1971. Southern Zuni Mountains. Scenic trips to the geologic past No. 4. N. Mex. Tech., Socorro, N. Mex. 75 pp.

Gates, G. H. 1972. Capture of free-ranging desert sheep in Sonora, Mexico., Desert Bighorn Council Transactions. 16 pp.:97-101.

Gordon, S. P. 1956. Mexican border big game management. Job completion report W-068-R. N. Mex. Dept. of Game and Fish, Santa Fe.

Gross, J. E. 1960. History, and present and future status of the desert bighorn sheep (Ovis canadensis mexicana) in the Guadalupe Mountains of southeastern New Mexico and northwestern Texas. Trans. Desert Bighorn Council 4:66-71.

Hansen, C. G. 1971. Habitat evaluation. In the desert bighorn: Its life history, ecology and management. Desert Bighorn Council, L. Summer and G. Monson (eds.). In press.

Hayward, B. J., T. C. Heiner and R. F. Miller. Resource inventory of the Alamo Hueco-Big Hatchet-Sierra Rica Mountain Complex. 155 pp.

Hightower, V. and G. H. Gates. 1973. Hand raising of desert bighorn lambs. Desert Bighorn Council Transactions. Pp. 164-166.

Lang, E. M. 1956. Sheep survey. Job completion report W-75-R-3, WP-3, Job 8. N. Mex. Dept. of Game and Fish. Santa Fe, N. Mex.

Ligon, J. S. 1939. Guadalupe bighorn survey report. Carbon on file, Dept. of Game and Fish, Santa Fe, N. Mex. Typed and incomplete.

Maker, H. J., H. E. Dregne, V. G. Link and J. U. Anderson. 1974. Soils of New Mexico. N. Mex. St. Univ. Ag. Exper. Sta. 132 pp.

Martin, P. B. and P. J. Mehringer. 1965. Pleistocene pollen analysis and biogeography of the southwest. Pp. 433-451, In the Quaternary of the United States. H. E. Wright, Jr. and D. G. Frey (eds.). Princeton Univ. Press, Princeton, New Jersey.

Mearns, E. A. 1907. Mammals of the Mexican boundary of the United States, Part I. U.S. Nat. Mus. Bull. 56. 530 pp.

Monson, G. C. 1971. Distribution and abundance. In the desert bighorn: Its life history, ecology and management. Desert Bighorn Council, L. Summer and G. Monson (eds.). In press.

Montoya, B. 1973. Bighorn sheep capture techniques. Desert Bighorn Council Transaction. 17. Pp. 155-163.

Neher, R. E. and W. A. Buchanan. 1973. Soil survey of Luna County, New Mexico. U.S.D.A., Soil Cons. Serv.

Newell, N. D. 1953. The Permian reef complex of the Guadalupe Mountains Region, Texas and New Mexico. W. H. Freeman and Co., San Francisco, Calif. 236 pp.

Pearce, T. M. 1965. New Mexico place names. Univ. of New Mexico Press, Albuquerque, N.M.

Sands, J. L. 1963. Investigations of former bighorn sheep range in west central New Mexico. Job completion report W-93-R-5, WP-5, Job 3. N. Mex. Dept. of Game and Fish. Santa Fe, N. Mex.

Sherman, E. and B. H. Sherman. 1975. Ghost towns and mining camps of New Mexico. Univ. of Okla. Press, Norman, Okla. 270 pp.

Simmons, L. W. May 22, 1946. Letter to Elliott S. Barker. N. Mex. Dept. of Game and Fish files. Santa Fe, New Mexico.

Simpson, C. D. 1978. The Barbary sheep: A threat to desert bighorn survival. Unpub. paper presented at the 22nd annual meeting of the Desert Bighorn Council. Kingman, Arizona.

Snow, R. and E. Zimmerman. 1939. Bighorn sheep report. Carbon on file, N. Mex. Dept. of Game and Fish, Santa Fe, New Mexico. Typed and incomplete.

Sutcliffe, D. H. 1971. The Ladron Mountains as a release site for Siberian ibex. M.S. Thesis. N. Mex. St. Univ.,,Las Cruces, N. Mex.

Ungnade, H. E. 1965. Guide to the Mountains of New Mexico. Univ. of N. Mex. Press. Albuquerque, N. Mex. 235 pp.

Watts, T. 1978. Performance report. Project number W-122-R-1. Habitat requirements of desert bighorn sheep in the Big Hatchet Mountains. N. Mex. Dept. of Game and Fish, Santa Fe, N. Mex.

Woltering, L. 1978. Grazing records of the Guadalupe and Sacramento Mountains. Letter to Andrew Sandoval. N. Mex. Dept. of Game and Fish files. Las Cruces, N. Mex.

Wood, J. G., R. J. White and J. L. Durham. 1970. Investigations preliminary to the release of exotic ungulates in New Mexico. N. Mex. Dept. of Game and Fish. Bull. No. 13.

APPENDICES

Appendix 1

System used in classifying desert bighorn habitat

Introduction

The purpose of this system is to qualitatively evaluate lands in New Mexico for desert bighorn sheep (Ovis canadensis mexicana) using environmental characteristics and value for man's use. In addition to evaluating lands, the method points out local factors limiting bighorn use. The rating system is based on a numerical score. The score is obtained by adding together points or numerical values assigned to the various components of the habitat.

Habitat Ratings:

a. Not important to bighorn, or of high value for human use.

b. Buffer Zone or Zone of Deficiency for bighorn, or area of potential economic value or of moderate human use.

c. Periodic use or Zone of Deficiency for bighorn, or area of potential economic value or of occasional human use.

d. Important to bighorn sheep.

e. Vital to bighorn sheep.

Tools:

a. Natural Topography

b. Vegetation Types

c. Precipitation

d. Evaporation

e. Water, Type and Use

f. Human Use

Each tool was broken down into separate components of the habitat that influence the presence or absence of sheep in that type of habitat. The values are assigned in such a way that human use, both actual and potential, would be favored in the less precipitous habitat and the bighorn sheep would be favored in the areas that are vital to their existence. When there is a conflict of interest or the area is not very important to sheep use, the system indicates the land as a buffer zone.

The names, numbers and point values of the Tools used in evaluating desert bighorn sheep habitat in New Mexico.

Tool Number	Name	Points
I	Natural Topography	0 to 20
II	Vegetation Type	0 to 20
III	Precipitation	1 to 10
IV	Evaporation	1 to 10
V	Water, Type and Use	2 to 20
VI	Human Use	0 to 20

Major classification of total scores for evaluating habitat for desert bighorn sheep.

Total Score	
0 to 50	NOT IMPORTANT TO BIGHORN, OR OF HIGH VALUE FOR HUMAN USE. Areas that fall within this rating and have a score for Tool I of 8 or less are not important to bighorn sheep. Sections that have a score of 12 or more for Tool I may be in a Zone of Deficiency, such as inadequate water supply nearby.
51 to 64	BUFFER ZONE OR ZONE OF DEFICIENCY FOR BIGHORN; OR AREA OF POTENTIAL ECONOMIC VALUE OR OF MODERATE HUMAN USE. Sections that fall within this rating are ones which should be retained, at least in their present status as a buffer against human encroachment. However, these areas may be improved upon for bighorn sheep use in various ways through habitat manipulation or by a change in human use.
65 to 79 (marginal habitat)	PERIODIC USE OR ZONE OF DEFICIENCY FOR BIGHORN; OR AREA OF POTENTIAL ECONOMIC VALUE OR FOR OCCASIONAL HUMAN USE. Sections that are within this category would be more valuable to bighorn sheep if some segment of the habitat were improved for them or if the economic potential or use were reduced or eliminated. However, there may be some feature of the terrain or vegetation that is necessary for the survival even though it may be used only periodically. Therefore, areas in this category should be critically examined before being removed from consideration.
80 to 100 (good habitat)	IMPORTANT TO BIGHORN SHEEP. Sections in this category are important to bighorn. The importance may be due to items essential to the animals or because of the lack of human use or economic potential. Generally, sections in this category are in rough, mountainous terrain or they are areas that are major crossings from and to summer and winter ranges or to water sources.

100 and above (optimum habitat)	VITAL TO BIGHORN SHEEP. Areas that are vital to bighorn are those that have some features without which the sheep cannot survive. The only areas that would fall in this category are those that have water sources within them.

Explanation of the Tools

TOOL I NATURAL TOPOGRAPHY

Value	Description
0 -	Level or slightly undulating (100%) (Example: Llanos, playas, and their margins) that is more than one mile from Steep and Rocky Terrain.
4 -	Level or slightly undulating (100%) within one mile of Steep and Rocky Terrain.
8 -	Rolling Hills (such as alluvial fans) without washes over 300 feet wide and/or more than one-half mile from Steep and Rocky Terrain.
12 -a)	Steep and Rocky (100%) with some washes or arroyos.
-b)	Rolling Hills broken frequently by broad washes and within one-half mile of Steep and Rocky Terrain.
-c)	Mesa-type terrain.
-d)	Lava-type terrain.
-e)	Homogenous (unbisected) stair-step
16 -	Steep and Rocky Terrain with washes and arroyos (50 to 90%) and Level or Rolling Hills (75 to 100%), with some rock outcrops.
20 -	Steep and Rocky Terrain broken frequently by canones of varying widths with at least one main wash 50 feet wide, more or less, and side drainages at various angles for protection from the elements and for escape cover.

TOOL II VEGETATION TYPE

Value	Type and Amount
0 -	Coniferous forest, *Pinus-Juniperus* woodland, or *Larrea*, *Prosopis*, *Flourensia* and *Yucca* llanos.
4 -	Mountain Shrub/*Pinus-Juniperus* woodland. Riparian (river bottom; i.e. Gila Middle Box north of Ira Ridge).
6 -	Mixed Shrub/*Pinus-Juniperus* woodland.
8 -	Mixed Shrub/Mountain Shrub - between Upper Sonoran and Transition zones.

Value	Type and Amount (Contd.)
10 -	Desert Shrub/Grass (grass 100% available and 5% of the cover).
12 -	Homogenous grassland (grass 100% available and 70% of the cover).
14 -	Savannah-type (grass 100% available and 50% of the cover). Grass/Desert Shrub
16 -	Grass/Mixed Shrub (60% desert shrubs, 40% mountain shrubs).
18 -	Mixed Shrub/Desert Shrub (grass 100% available and 10% of the cover).
20 -	Grass/Mixed Shrub (grass 100% available and 25% of the cover), transition between Lower and Upper Sonoran zones.

TOOL III PRECIPITATION

Amount		Type and Time of Year
Value	Annual Total Inches	
2 -	4 to 6	Primarily thundershowers during the warm season.
4 -	6 to 8	Warm season showers primarily.
6 -	8 to 10	Warm season showers primarily.
8 -	8 to 10	Showers or general storms approximately 1/3 during the cool season and 2/3 during the warm season.
10 -	10 to 15	Showers or general storms approximately 1/3 during the cool season and 1/3 during the warm season.

TOOL IV EVAPORATION

Value	Evaporation Loss	Humidity Plus Wind		
		Humidity	Wind	
			Velocity	Frequency
2 -	More than 5 inches	10% or less	Moderate Strong	Daily Occasionally
4 -	4 to 5 inches	11% to 17%	Moderate Strong	Daily Frequently
6 -	Approximately 3 inches	20%	Gentle Moderate Strong	Daily Frequently Seldom

TOOL IV EVAPORATION (Contd.)

Value	Evaporation Loss	Humidity Plus Wind		
		Humidity	Wind	
			Velocity	Frequency
8 -	Approximately 2 inches	23% to 27%	Gentle Moderate Strong	Daily Frequently Seldom
10 -	1 inch or less	30% or more	Any velocity	Occasional

These figures should be weekly averages during summer months, when temperatures are 90°F or more.

TOOL V WATER SOURCES, TYPE AND USE

Value	Amount and Permanence
1 -	Water present irregularly, mainly in the summer.
2 -	Often dry when needed in spring and summer during dry years.
5 -	Dry half of the time when needed during dry springs and summers.
7 -	Seldom dry during the spring and summer.
10 -	Sufficient and always present.

Value	Type of Terrain and Obstructions
1 -	Flat land; water surrounded by fences, etc., or steep-sided dam or pothole.
2 -	Open Rolling Hills; surrounded by a corral, etc., that is passable, or about 1/2 mile from Steep and Rocky Terrain. River bottom, surrounded by dense riparian vegetation. Deep timbered canyon.
3 -	Rolling Hills, timbered areas, or other natural obstructions to vision.
4 -	Steep and Rocky but with some timber or minor obstruction.
5 -	Open Steep and Rocky Terrain with a clear view for at least 100 yards.

Value	Competition
1 -	Frequent livestock use.
2 -	Some livestock, feral animal, or native big game use.
3 -	Mostly big game use.
4 -	Some native big game use.
5 -	No native big game or livestock use.

Only land sections within four miles of a water hole are to be given the value as listed. Areas between four to nine miles of a water source are to receive only 50% of that assigned to the nearest water source. Any section that is more than 10 miles or more from the nearest water source will receive a value of zero for this TOOL. Any section that has a water source within it will receive twice the total value as scored for this TOOL. When two or more water sources occur within four miles of a section, the maximum points available are 20. These 20 points are received only when each water source has a value of 10 or more points. Otherwise the section will receive only the value of the water source with the highest value.

TOOL VI HUMAN USE

Points	Class	Description of Density and Utilization
0	I	High Density Human Use and/or Economic Potential
2	II	Medium to Low Density Human Use and/or Economic Potential (unrestricted).
6	III	Medium Density Human Use and/or Economic Potential with some restrictions.
	IV	Medium Density Human Use restricted and Medium Economic Potential.
8	V	Medium Density Human Use unrestricted and Low or No Economic Potential.
	VI	Planned development for wildlife with some unrestricted Human Use and with some degree of Economic Potential.
10	VII	Medium Density Human Use with restrictions and No Economic Potential.
15	VIII	Low Density Human Use unrestricted and Low or No Economic Potential.
20	IX	Relatively No Human Use and No Economic Potential.

Human use includes buildings, roads, recreation, grazing, prospecting, etc. Economic use or economic potential refers to mining (oil or mineral), industrial or commercial (including urban) development, farming or ranching, etc.

High density human use refers to urban areas, roads or recreation areas used by hundreds of people each week, or concentrated economic development with a constant use by a few people, such as ore trucks, etc.

Medium density human use refers to areas of recreation or a roadway where people (about 200) visit each year. Also included would be mining, hunting, grazing, or other commercial uses on a low scale.

Low density human use refers to areas of recreation or a roadway where less than 50 people visit each year or where occasional prospecting, grazing, hunting, etc., may occur.

Relatively no human use and no economic potential refers to human use for only the basic management needs of the habitat or wildlife in general. There may be only two or three visitor days a year by people other than wildlife managers. These visitors may be for any of the uses mentioned previously. About the only area meeting this criteria would be the San Andres Refuge.

Appendix 2

A partial list of plants identified from the Guadalupe Mountains

Trees

Scientific Name	Common Name
Acer grandidentatum	Bigtooth maple
Fraxinus velutina	Velvet ash
Juniperus deppeana	Alligator juniper
Juniperus monosperma	One seed juniper
Morus microphylla	Texas mulberry
Pinus flexilis var. *reflexa*	Limber pine
Pinus ponderosa	Ponderosa pine
Prunus virens	Southwestern chokecherry
Pseudotsuga menziesii	Douglas fir
Quercus gambelii	Gambel's oak
Ungnadia speciosa	Mexican buck-eye

Shrubs

Acacia spp.	White thorn
Agave palmeri	Mescal
Aloysia wrightii	Spice bush
Berberis trifoliolata	Algerita
Ceanothus greggi	Desert ceanothus
Cercocarpus breviflorus	Hairy mountain mahogany
Choisya dumosa	Starleaf
Dasylirion wheeleri	Sotol
Fallugia paradoxa	Apache plume
Fenderla rupicola	Cliff fendler bush
Glossopetalons spinescens	Grease-bush
Gutierrezia sarothrae	Broom snakeweed
Mimosa biuncifera	Mimosa
Nolina microcarpa	Sacahuista
Opuntia engelmanni	Prickly pear cactus
Opuntia spinosior	Cholla cactus
Parthenium incanum	Mariola
Ptelea pallida	Pale hoptree
Quercus spp.	Oak
Rhamnus californicus	California buckthorn
Rhus choriophylla	Evergreen sumac
Rhus trilobata	Skunk-bush sumac
Salvia pinquifolia	Sage
Selloa glutinosa	
Symphoricarpus spp.	Snowberry
Viguiera stenoloba	Skeleton leaf goldeneye
Vitis arizonica	Canyon grape
Yucca baccata	Datil yucca

Appendix 2 (cont'd.)

Grasses

Agropyron spicatum	Blue-bunch wheatgrass
Andropogon gerardii	Big bluestem
Andropogon saccharoides	Silver bluestem
Andropogon scoparius	Little bluestem
Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Bromus carinatus	Mountain brome
Koeleria cristata	June grass
Lycurus phleoides	Wolftail
Muhlenbergia emersleyi	Bullgrass
Panicum arizonicum	Arizona panic grass
Panicum obtusum	Vine mesquite grass
Sporobolus crytandrus	Sand dropseed

Forbs

Allium rhizomatum	Wild onion
Castelleja integra	Indian paintbrush
Cirsium wheeleri	Wheeler thistle
Eriogonum spp.	Buckwheat
Huechera versicolor	Alum root
Lesquerella purpurea	Bladder-pod
Notholaena sinuata	Wavy-leaf cloakfern
Oenothera spp.	Evening primrose
Senecio douglasii	Thread-leaf groundsel
Thelesperma longipes	Te de cota
Verbascum thapsus	Indian tobacco

Appendix 3

Water Sources - Guadalupe Mountains

Name	Type	Location	Remarks
Kirkland Spring		NE¼ of NW¼ of S-7, T 25S, R 23E	
Horse Canyon Spring		SW¼ of SE¼ of S-2, T 25S, R 22E	
Taylor Tank		NW¼ of SE¼ of S-10, T 25S, R 22E	Dark Canyon bisects this section from SW to NE.
Horse Seep		SW¼ of SW¼ of S-12, T 25S, R 22E	
The Falls		SW¼ of NW¼ of S-34, T 25S, R 22E	Located in Main Double Canyon.
Hidden Seep		NW¼ of NE¼ of S-6, T 26S, R 22E	
Double Canyon Tank	Earthen Tank	SW¼ of S-1, T 26S, R 22E	Section 1 includes mouths of North Fork Double Canyon and Lefthook Canyon.
Pacific Slope Tank		NE¼ of SW¼ of S-3, T 26S, R 22E	
Lower Black Canyon Spring		NE¼ of NE¼ of S-7, T 26S, R 22E	Water is located within North Fork Black Canyon.
Franks Spring		SW¼ of NW¼ of S-15, T 26S, R 22E	Water is located at the mouth of Black Canyon.
Gunsight Canyon Tank	Earthen Tank	NE¼ of SE¼ of S-14, T 26S, R 22E	
Mescal Seep		NE¼ of NE¼ of S-18, T 26S, R 22E	Seep is located in the South Fork Black Canyon. Lonesome Ridge Trail (USFS 56) crosses section 18 from NW to SE.
Frank Flats Tank		NW¼ of NW¼ of S-13, T 26S, R 22E	
Calamity Tank	Metal Stock Tank	SE¼ of NE¼ of S-26, T 26S, R 22E	

Water Sources - Guadalupe Mountains (cont'd.)

Name	Type	Location	Remarks
Lower South Rattlesnake Spring		NE¼ of SE¼ of S-5, T 25S, R 24E	
Upper South Rattlesnake Spring		SE¼ of SW¼ of S-12, T 25S, R 23E	
North Rattlesnake Canyon Spring		NE¼ of SE¼ of S-32, T 24S, R 24E	North Rattlesnake Canyon bisects section 32.
Irabarne Tank		NW¼ of NW¼ of S-8, T 25S, R 21E	USFS Road 67 bisects this section from North to South.
Shattuck W. Tank		NE¼ of SW¼ of S-9, T 25S, R 21E	
Effondale Tank		NE¼ of SW¼ of S-20, T 25S, R 21E	
Kuykendall Tank		NE¼ of NE¼ of S-21, T 25S, R 21E	
Hooper Tank		NE¼ of NE¼ of S-33, T 25W, R 21E	
Jackson Tank		SE¼ of S-5, T 25S, R 21E	
Soldier Spring		NW¼ of SE¼ of S-10, T 26S, R 21E	
Black Canyon Spring		NE¼ of SE¼ of S-2, T 26S, R 21E	
Brister Tank		SW¼ of SW¼ of S-25, T 25S, R 20E	Brister Tank is at the extreme end of Last Chance Canyon.
Unnamed	Earthen Tank	NW¼ of SW¼ of S-2, T 25S, R 20E	
Unnamed	Earthen Stock Tank	SW¼ of NW¼ of S-13, T 25S, R 20E	
Irabarne Tank #2		SW¼ of S-15, T 24S, R 20E	
Coats Lake		SW¼ of NE¼ of S-23, T 24S, R 20E	
Guadalupe Tank		NE¼ of S-3, T 25S, R 20E	

Water Sources - Guadalupe Mountains (cont'd.)

Name	Type	Location	Remarks
Rawhide Tank	Earthen Stock Tank	SW¼ of NE¼ of S-34, T 23S, R 20E	
Indian Tank		SW¼ of S-31, T 22S, R 20E	
Woods Tank		NE¼ of SE¼ of S-5, T 23S, R 19E	Little Dog Canyon bisects the SE¼ of S-5.
Algerita Tank		NW¼ of SE¼ of S-16, T 23S, R 20E	
The Rim Tank	Naturally-occurring tank	NW¼ of NE¼ of S-28, T 23S, R 20E	
South Algerita Flat	Earthen Tank	NE¼ of NW¼ of S-27, T 23S, R 20E	USFS Road 67 bisects Section 27 from N to S.
Rawhide #2	Naturally-occurring tank	NW¼ of NE¼ of S-28, T 23S, R 20E	
Upper Dog	Tank	NE¼ of NE¼ of S-18, T 22S, R 19E	
Lower Dog	Tank	SE¼ of NW¼ of S-17, T 22S, R 19E	Little Dog Canyon bisects section 17 from NW to SE.
Cantrell Lake		NE¼ of NE¼ of S-11, T 22S, R 18E	
Hayhurst Spring		SE¼ of NW¼ of S-8, T 25S, R 23E	
Cottonwood Spring		SE¼ of NE¼ of S-14, T 25S, R 23E	Water is located on the East Wall of North Slaughter Canyon.
Dinner Hill #1	Spring	SE¼ of SW¼ of S-12, T 25S, R 23E	
Dinner Hill #2	Spring	SW¼ of SE¼ of S-12, T 25S, R 23E	
West Slaughter Spring		SE¼ of NW¼ of S-29, T 25S, R 23E	
Thurman	Earthen Tank	SW¼ of S-6, T 26S, R 23E	
Gordon Seep		NW¼ of NW¼ of S-13, T 25S, R 21E	

Water Sources - Guadalupe Mountains (cont'd.)

Name	Type	Location	Remarks
Devils Den	Spring	NW¼ of NE¼ of S-21, T 25S, R 21E	
Camp Wilderness	Seep	NW¼ of S-26, T 26S, R 21E	
North McKittrick	Spring	S-26, T 26S, R 21E	
Lower Dark Canyon	Spring	NW¼ of NW¼ of S-31, T 24S, R 23E	

Appendix 4

A partial plant list of the Sacramento Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Agave parryi	Mescal
Atriplex canescens	Fourwing saltbush
Berberis trifoliolata	Algerita
Ceanothus greggi	Desert ceanothus
Cercocarpus montanus	Mountain mahogany
Choisya dumosa	Starleaf
Dasylirion wheeleri	Sotol
Juniperus deppeana	Alligator juniper
Juniperus monosperma	One seed juniper
Nolina microcarpa	Sacahuista
Parthenium incanum	Mariola
Pinus edulis	Piñon pine
Pinus ponderosa	Ponderosa pine
Pseudotsuga menziesii	Douglas fir
Quercus gambelii	Gambel's oak
Rosa stellata	Wild rose
Viguiera stenoloba	Skeleton leaf goldeneye
Yucca baccata	Datil yucca

Grasses

Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia porteri	Bush muhly
Stipa lettermani	Letternan's needlegrass
Stipa neomexicana	New Mexican needlegrass

Forbs

Lesquerella purpurea	Bladder-pod
Verbesina encelioides	Crownbeard

Appendix 5

Water Sources - Sacramento Mountains

Name	Type	Location	Remarks
Wild Boy	Spring	SW¼ of NE¼ of S-14, T 19S, R 11E	
Mineral	Spring	NW¼ of SW¼ of S-10, T 16S, R 10E	
Upper Marble	Spring	NE¼ of NE¼ of S-27, T 16S, R 10E	
Mule	Spring	SW¼ of SW¼ of S-14, T 17S, R 10E	
San Andres	Spring	NE¼ of NE¼ of S-35, T 17S, R 10E	
Lead Canyon Well	Windmill	SW¼ of SE¼ of S-20, T 17S, R 10E	
Dog Canyon	Spring	NW¼ of SE¼ of S-11, T 18S, R 10E	
Laney	Spring	SE¼ of NW¼ of S-23, T 18S, R 10E	
Dripping	Spring	SW¼ of NE¼ of S-30, T 18S, R 11E	
Grapevine Canyon	Spring	NE¼ of SW¼ of S-35, T 19S, R 11W	

Appendix 6

A partial plant list identified in the Caballo Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Acacia constricta	White-thorn
Agave parryi	Mescal
Artemisia ludoviciana	Sagebrush
Atriplex canescens	Fourwing saltbush
Berberis trifoliolata	Algerita
Brickellia spp.	
Ceanothus greggi	Desert ceanothus
Cercocarpus montanus	Mountain mahogany
Choisya dumosa	Starleaf
Chrysothamnus nauseosus	Rabbit-brush
Cowania stansburiana	Cliff-rose
Dasylirion wheeleri	Sotol
Eurotia lanata	Winter-fat
Fallugia paradoxa	Apache plume
Fouquieria splendens	Ocotillo
Garrya flavescens	Quinine-bush
Garrya wrightii	Wright's silktassel
Glossopetalon spinescens	Grease-bush
Gutierrezia sarothrae	Broom snakeweed
Juniperus monosperma	One seed juniper
Koeberlinia spinosa	Spiny allthorn
Larrea tridentata	Creosote bush
Nolina microcarpa	Sacahuista
Opuntia engelmanni	Prickly pear cactus
Opuntia spinosior	Cholla cactus
Parthenium incanum	Mariola
Pinus edulis	Piñon pine
Prosopis juliflora	Common mesquite
Quercus turbinella	Shrub live oak
Rhus microphylla	Little-leaf sumac
Rhus trilobata	Skunk-bush sumac
Tetradymia filifolia	Horse-brush
Yucca baccata	Datil yucca

Grasses

Aristida adscensionis	Six weeks threeawn
Aristida arizonica	Threeawn
Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Bromus cartharticus	Brome
Koeleria cristata	June grass

Appendix 6 (cont'd.)

Grasses (cont'd.)

Leptochloa dubia	Green sprangletop
Lycurus phleoides	Wolftail
Muhlenbergia arenicola	Muhly grass
Muhlenbergia monticola	Muhly grass
Muhlenbergia porteri	Bush muhly
Muhlenbergia sp.	Muhly grass
Sporobolus sp.	Drop seed
Stipa lettermani	Letterman's needlegrass

Forbs

Eriogonum sp.	Buckwheat
Hedeoma drummondi	Mock pennyroyal
Lesquerella purpurea	Bladder-pod
Notholaena sinuata	Wavy-leaf cloakfern
Phoradendron coryae	Mistletoe
Sisymbrium linearifolium	Mustard
Sphaeralcea sp.	Globemallow
Thelesperma longipes	Te de cote
Verbesina encelioides	Crownbeard

Appendix 7

Water Sources - Caballo Mountains

Name	Type	Location	Remarks
Saddle Tank	Earthen tank	NW¼ of NE¼ of S-6, T 16S, R 3W	
Granite Spring		SE¼ of NW¼ of S-4, T 16S, R 4W	
Caballo Lake		Borders west side of study area	
Rain catchment unit		SE¼ of S-12, T 16S, R 4W	Water source is livestock rain catchment unit located in SE¼ of this sec. Unit consists of fenced-in (gameproof) area approx. 75 yds. x 75 yds. Water collects in two rubber aprons, 1 about 100' x 100'; the other 50' x 25'. Drinking basin consists of metal tank about 10' long, 3' wide and 2' deep.
Apache Gap Tank	Earthen tank	NE¼ of NW¼ of S-19, T 16S, R 3W	
Apache Gap Windmill		NE¼ of NW¼ of S-19, T 16S, R 3W	
Grass Tank	Earthen tank	SE¼ of NE¼ of S-7, T 16S, R 3W	
Jacks Tank	Earthen tank	SW¼ of S-17, T 16S, R 3W	
Red Tank	Earthen tank	NW¼ of NW¼ of S-7, T 15S, R 3W	Red Tank is located at junction of Hadley Canyon and Red Canyon.
Homestead Tank	Earthen tank	NW¼ of NE¼ of S-30, T 15S, R 3W	
Lyons Homestead Tank	Earthen tank	NW¼ of NE¼ of S-31, T 15S, R 3W	Lyons Homestead is found at same location, dwelling appears to get periodic use.
Rio Grande River			

Water Sources - Caballo Mountains (cont'd.)

Name	Type	Location	Remarks
Mescal	Spring	SW¼ of S-6, T 14S, R 3W	
Unnamed	Spring	SE¼ of NE¼ of S-18, T 16S, R 3W	
Bootleggers	Windmill	NE¼ of NE¼ of S-35, T 14S, R 4W	
L-7 Red Tank	Earthen tank	SW¼ of SE¼ of S-18, T 15S, R 3W	
Ash	Spring	SE¼ of SW¼ of S-21, T 15S, R 3W	
Basin Tank	Earthen tank	SE¼ of NE¼ of S-23, T 15S, R 4W	
Chambers Canyon	Spring	SE¼ of NW¼ of S-33, T 15S, R 4W	

Appendix 8

A partial plant list of the Fra Cristobal Mountains

Shrubs and trees

Scientific Name	Common Name
Berberis trifoliolata	Algerita
Cercocarpus montanus	Mountain mahogany
Dalea sp.	Pea bush
Dasylirion wheeleri	Sotol
Ephedra viridis	Mormon tea
Eurotia lanata	Winter-fat
Fouquieria splendens	Ocotillo
Juniperus monosperma	One seed juniper
Larrea tridentata	Creosote bush
Opuntia engelmanni	Prickly pear cactus
Parthenium incanum	Mariola
Pinus edulis	Piñon pine
Rhus trilobata	Skunk-bush sumac
Yucca baccata	Datil yucca

Grasses

Aristida sp.	Needlegrass
Bouteloua curtipendula	Sideoats grama
Lycurus phleoides	Wolftail
Stipa sp.	Needle

Forbs

Artemisia sp.	Sage
Mirabilis multiflora	Four o'clock
Verbena wrightii	Verbena
Verbesina encelioides	Crownbeard

Appendix 9

Water sources located in the Fra Cristobal Mountains

Name	Type	Township	Range	Section	Location	Comments
Hackberry Spring	Metal stock tank	11S	3W	24	SW¼ of NW¼	Located in small, narrow, west-draining canyon. Water is piped about 100 yds. to a large (20 ft. dia. x 2 ft.) tank. Water is located in steep, open, rocky terrain.
Walnut Seeps	Spring	11S	3W	24	SW¼ of SW¼	Located at mouth of Walnut Canyon. Terrain is steep, rocky, and open except at drinking area which is obscured by *Celtis* and *Jugulans* trees. Water seeps out of two other localities within Walnut Canyon, about 400 and 300 meters, respectively, from Walnut Spring.
Mine Canyon	Windmill	10S	3W	2	SE¼ of NE¼	Located at the mouth of Mine Canyon on the NW side of mtn. range. Source consists of metal storage, closed-type windmill, a metal stock tank (6 ft. dia. x 1.5 ft.). Elevation 4,520 ft. Source was dry on 12-1-77.
Spellmeyer	Windmill	11S	2W	10	SW¼ of SW¼	Located about 1.25 miles E. of mtn. range. Consists of windmill and 2 concrete drinking troughs. Windmill and 1 trough are fenced in.

Water sources located in the Fra Cristobal Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Bert Cook	Windmill	12S	3W	12	SW¼ of SE¼	Located within Reynolds Canyon in the alluvium of the southwest-facing cliffs of the lower unit of the mtn. range. Source is situated in a N.E.-facing basin, where Reynolds Canyon pinches to a gooseneck. Source consists of windmill, large (30 ft. dia. x 5 ft.) defunct metal stock tank, a concrete underground storage tank, and concrete drinking trough (8 ft. x 2 ft. x 1 ft.).
Scenic Spring	Metal stock tank	11S	3W	24	SE¼ of SE¼	Located in south fork of Walnut Canyon in steep, open country. Water is piped from source about 75 yds. to tank (12 ft. dia. x 5 ft.). Drinking basin is round metal tub. Tank and tub were dry on 11-30-77.
Silver Canyon	Tank	11S	2W	6	SE¼ of NE¼	
Red Gap	Tank	11S	2W	19	NW¼ of NW¼	Deer were observed (12-2-77) utilizing water source.
Rio Grande	River	9S	3W	36	West 1/3 of section	
Lava Well Ranch	Well	10S	2W	4		Source is along northern boundary of Sec. 4 to the east.

Appendix 10

A partial plant list of the San Mateo Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Abies concolor	White-fir
Acer grandidentatum	Big-tooth maple
Alnus spp.	Alder
Aloysia wrightii	Spicebush
Artemisia spp.	Sagebush
Atriplex canescens	Fourwing saltbush
Berberis trifoliolata	Algerita
Celtis reticulata	Netleaf hackberry
Cercocarpus montanus	Mountain mahogany
Dasylirion wheeleri	Sotol
Ephedra sp.	Jointfir
Fallugia paradoxa	Apache plume
Fendlera rupicola	Cliff fendlerbush
Garrya wrightii	Wright's silktassel
Gutierrezia sarothrae	Broom snakeweed
Holodiscus dumosa	Rock spiraea
Juglans major	Arizona walnut
Juniperus deppeana	Alligator juniper
Juniperus monosperma	One seed juniper
Opuntia engelmanni	Prickly pear cactus
Opuntia spinosior	Cholla
Picea engelmanni	Engelmann spruce
Pinus edulis	Piñon pine
Pinus flexilis	Limber pine
Pinus ponderosa	Ponderosa pine
Platanus wrightii	
Populus angustifolia	Narrowleaf cottonwood
Populus tremuloides	Trembling aspen
Pseudotsuga taxifolia	Douglas fir
Quercus gambeli	Gambel's oak
Quercus grisea	Gray oak
Rhus trilobata	Skunk bush sumac
Rhus microphylla	Little-leaf sumac
Rosa stellata	Wild rose
Salix spp.	Willow
Tamarix pentandra	Salt cedar
Yucca baccata	Datil yucca
Yucca elata	Soaptree yucca

Appendix 10 (cont'd.)

Grasses

Andropogon furcatus	Big bluestem
Andropogon saccharoides	Silver bluestem
Andropogon spicatum	Blue-bunch wheatgrass
Andropogon scoparius	Little bluestem
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Leptochloa dubia	Green sprangletop
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia monticola	New Mexico muhly
Muhlenbergia rigens	Deergrass

Appendix 11

Water Sources - San Mateo Mountains

Name	Type	Location	Remarks
Turkey Spring		NW¼ of NE¼ of S-11, T 9S, R 6W	
Myers Spring		NW¼ of SE¼ of S-3, T 9S, R 6W	Spring located in Shipman Canyon.
Oak Spring		NE¼ of SE¼ of S-4, T 9S, R 6W	Section includes the west slope of San Mateo Mountain (10, 145).
Whitetail Spring		NE¼ of NE¼ of S-5, T 9S, R 6W	Whitetail Spring is in Whitetail Canyon.
Whitetail Tank		SE¼ of SE¼ of S-5, T 9S, R 6W	Temporary water is found in Whitetail Tank.
San Mateo Canyon	Intermittent flow	S-6 and S-7, T 9S, R 6W	Water seeps out at intervals within San Mateo Canyon.
Shipman Spring		NW¼ of SE¼, S-16, T 9S, R 6W	
Rock Spring		SW¼ of SW¼ of S-12, T 9S, R 6W	USFS Rd. 225 traverses this section along the West side.
Lower Rock Spring		SE¼ of NE¼ of S-14, T 9S, R 6W	
Villa Nueva Spring		SW¼ of SE¼ of S-15, T 9S, R 6W	Cañon de Quiriño enters this section.
Jolla Tank	Earthen tank	NW¼ of SE¼ of S-25, T 9S, R 6W	Section includes Luna Park Campground and Questa de Trujillo.
Calvario Spring		SW¼ of SE¼ of S-27, T 9S, R 6W	
Unnamed	Series of springs and waterfalls	S-27, T 9S, R 6W	Located within Cañon de Quiriño. At least 4 falls are over 10 feet high.
Las Uvas Spring		SW¼ of SE¼ of S-35, T 9S, R 6W	About six prospects are located approximately ¼ mile NE of Uvas Spring.
Questa Spring		SE¼ of NW¼ of S-36, T 9S, R 6W	USFS Rd. 225 traverses this section from North to South.

Appendix 12

A partial plant list from the Magdalena Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Abies concolor	White fir
Acer negundo	Box elder
Cercocarpus montanus	Mountain mahogany
Fallugia paradoxa	Apache plume
Gutierrezia spp.	Snakeweed
Holodiseus dumosus	Rockspireae
Juglans major	Arizona walnut
Juniper deppeana	Alligator juniper
Opuntia spinsior	Cholla
Picea engelmanni	Engelman spruce
Pinus edulis	Piñon pine
Pinus flexilis var. *reflexa*	Limber pine
Pinus ponderosa	Ponderosa pine
Populus tremuloides	Quaking aspen
Populus spp.	Cottonwood
Prunus virginiana var. *demisa*	Chokecherry
Pseudotsuga menziesii	Douglas fir
Quercus gambelli	Gambel's oak
Ribes spp.	Currants
Robinia neomexicana	New Mexican locust
Rupicola fendleri	Cliff fendlerbush
Yucca baccata	Datil yucca

Appendix 13

Water sources located in the Magdalena Mountains

Name	Type	Township	Range	Section	Location	Comments
Muleshoe	Spring	4S	3W	12	NE¼ of SE¼	
Baldy	Spring	4S	3W	18	SE¼ of SE¼	Elevation 9,920 ft.
Puertocito	Windmill	5S	3W	19	NW¼ of NW¼	
Copper Canyon	Well	5S	3W	22	SW¼ of NW¼	Elevation 6,272 ft.
Antelope Well	Windmill	6S	3W	19	SW¼ of NW¼	
Agua Fria	Spring	3S	4W	25	NE¼ of NW¼	
Frenchie's Cabin	Spring	3S	4W	36	SE¼ of NE¼	
Rock	Spring	3S	4W	26	SE¼ of NW¼	
Hop Canyon	Windmill	3S	4W	11	NE¼ of SE¼	
Elephant	Spring	3S	4W	12	SW¼ of SW¼	
Jordan Canyon	Spring	3S	3W	5	SE¼ of SW¼	Second spring is located just below at canyon junction.
Lower Garcia (Strozzi Su)	Spring	3S	3W	10	NW¼ of SW¼	
Lower Ellis Canyon	Spring	2S	3W	33	SW¼ of NW¼	
Lower Hell Canyon	Spring	2S	3W	28	SW¼ of NW¼	

Water sources located in the Magdalena Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Hell Canyon	Spring	2S	3W	29	NW¼ of SW¼	
South Fork Ellis Canyon	Spring	2S	3W	30, 31, 32		Series of springs in So. Fork Ellis Cyn.
Pony	Spring	3S	3W	7	SW¼ of SW¼	
Upper Garcia (Garcia Canyon)	Spring	3S	3W	9	SW¼ of SW¼	
South Fork Jordan Canyon	Spring	3S	3W	8	SE¼ of NE¼	
Wet Weather	Spring	3S	3W	24	SE¼ of SE¼	
Shakespeare	Spring	3S	3W	15	NE¼ of SW¼	
North Fork	Spring	3S	3W			Series of springs near head of canyon.
Cabin	Spring	3S	3W	21	NW¼ of NW¼	
Water Canyon	Windmill	2S	3W	13	SW¼ of SW¼	
Upper Water Canyon	Spring	3S	3W	34	SE¼ of SW¼	
Copper Canyon	Spring	3S	3W	27	NE¼ of SW¼	
Kelly Ranch	Windmill	3S	3W	23	SE¼ of SW¼	
Buttercup	Spring	4S	4W	14	NW¼ of NW¼	
Upper Bear Canyon	Spring	4S	4W	1	SW¼ of SE¼	Elevation 8,590 ft.

Water sources located in the Magdalena Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Rockslide	Spring	4S	3W	21	NE¼ of SE¼	
South Baldy	Spring	4S	3W	6	SE¼ of SE¼	Located just below timberline in the timber.
North Baldy (Upper Garcia Canyon)	Spring	3S	3W	17	NW¼ of NE¼	Located within Garcia Canyon.
Buck	Spring	4S	3W	11	SE¼ of SW¼	Elevation 7,780 ft.
South Canyon	Spring	4S	3W	3	NW¼ of SW¼	Elevation 8,250 ft.
Upper South Canyon	Spring	4S	3W	4	SE¼ of SW¼	Elevation 9,400 ft.
Upper Hardy	Spring	4S	4W	12	NE¼ of SE¼	Elevation 8,640 ft.
Upper E. Fork Sawmill Canyon	Spring	4S	3W	17	SW¼ of NW¼	Elevation 8,480 ft.
Upper E. Fork Sawmill Canyon	Spring	4S	3W	18	SE¼ of NE¼	Elevation 8,600 ft.
Timber Peak	Spring	4S	3W	9	NE¼ of SE¼	Elevation 8,720 ft. and 9,080 ft.
Six-mile	Spring	4S	3W	10	NW¼ of SW¼	Elevation 8,520 ft.
Section 14	Spring	4S	3W	14	NW¼ of SE¼	Elevation 7,760 ft.
Box	Spring	4S	2W	7	NW¼ of NE¼	Elevation 6,760 ft.
Lower Six-mile	Spring	4S	3W	12	SE¼ of NW¼	

Water sources located in the Magdalena Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Rockslide	Spring	4S	3W	21	NE¼ of SE¼	Elevation 8,640 ft.
Molino	Spring	4S	3W	24	NW¼ of SE¼	Elevation 7,620 ft.
Ryan Hill	Spring	4S	3W	26	SW¼ of SE¼	
Sawmill	Spring	4S	3W	4	SW¼ of NE¼	Elevation 6,600 ft.
West Fork Sawmill Canyon	Spring	4S	3W	19	SE¼ of NE¼	Elevation 7,800 ft.
East Fork Sawmill Canyon	Spring	4S	3W	20	NW¼ of NE¼	Elevation 8,040 ft.
Sawmill Canyon	Windmill	5S	3W	15	SW¼ of NE¼	
Haunted	Spring	5S	3W	9	SW¼ of SW¼	Elevation 7,440 ft.
Hardy	Spring	4S	4W	13	NW¼ of NE¼	Elevation 8,070 ft.
Upper Ryan Hill Canyon	Spring	4S	3W	15	SW¼ of SE¼	Elevation 8,120 ft.
Upper Italian	Spring	4S	3W	27	SE¼ of NW¼	

Appendix 14

A partial plant list from the Malpais

Trees

Scientific Name	Common Name
Juniperus monosperma	One seed juniper
Juniperus deppeana	Alligator juniper
Juniperus scopolorum	Rocky Mountain juniper
Pinus edulis	Pinon pine
Populus tremuloides	Quaking aspen
Pseudotsuga menziesii	Douglas fir
Quercus gambelii	Gambel's oak
Quercus grisea	Gray oak

Shrubs

Atriplex canescens	Fourwing saltbush
Berberis repens	Barberry
Brickellia californica	Brickel bush
Ceanothus fendleri	Buck-brush
Cercocarpus brevifolius	Mountain mahogany
Chrysothamnus greenei var. *filifolius*	Rabbit brush
Chrysothamnus nauseosus var. *pinifolius*	Rabbit brush
Fallugia paradoxa	Apache plume
Foresteria neomexicana	Adelia
Opuntia arborescens	
Physocarpus monogyrus	Ninebark
Rhus glabra	Scarlet sumac
Rhus trilobata var. *anisophylla*	Skunkbush sumac
Ribes cereum	Currant
Ribes inebrians	Squaw currant
Tetradymia canescens var. *inermis*	Horse brush

Grasses

Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Festuca arizonica	Fescue
Muhlenbergia montana	Mountain muhly
Sitanion hystrix	Squirrel tail

Forbs

Actinea richardsoni var. *floribunda*	Colorado rubber weed
Agastache neomexicana	Giant hyssop

Appendix 14 (cont'd.)

Forbs (cont'd.)

Allium cernuum	Nodding onion
Androsace septentrionalis var. *glandulosa*	Rock-jasmine
Aplopappus spinulosus var. *typicus*	
Arabis fendleri	Rock-cress
Arenaria confusa	Sandwort
Artemisia carruthii var. *wrightii*	Sagebrush
Asclepias tuberosa	Butterflyweed
Bahia dissecta	Yellow ragweed
Castilleja integra	Paintbrush
Chenopodium fremontii	Goosefoot
Chrysopsis hispida	Golden aster
Cirsium megacephalum	Thistle
Cryptantha jamesii var. *cinerea*	
Descurainia pinnata var. *halictorum*	Tansy mustard
Erigeron divergens	Fleabane
Erigeron jamesii	Fleabane
Frasera speciosa	Green gentian
Geranium atropurpureum	Cranesbill
Geranium fremontii	Cranesbill
Gilia aggregata	Gilia
Gilia haydenii	Gilia
Hesperidanthus linearifolius	
Hymenopappus robustus	
Lappula redowskii	
Lithospermum multiflorum	
Lotus wrightii	
Marrubium vulgare	Horehound
Mirabilis oxybaphoides	Four o'clock
Oenothera caespitosa var. *marginata*	Primrose
Pentstemon linarioides	Pentstemon
Pentstemon trichander	Pentstemon
Pericome caudata	Pericome
Phacelia intermedia	
Phaseolus angustissimus var. *latus*	
Portulaca retusa	
Pteridium aquilinum	
Selaginella rupincola	
Silene laciniata	
Solanum rostratum	Horse nettle
Sphaeralcea incana	Globemallow
Teucrium occidentale	
Thalictrum fendleri	
Verbena wrightii	Verbena
Woodsia plumerae	

Appendix 15

Water sources located in the Malpais

Name	Type	Township	Range	Section	Location	Comments
Section 29	Windmill	10N	9W	29	SW¼ of NW¼	
El Canoncito	Windmill	10N	9W	21	NE¼ of NE¼	
Section 31	Windmill	10N	9W	31	NE¼ of SW¼	
Rancho del Padre	Spring	10N	9W	7	NE¼ of NE¼	
Chical	Windmill	10N	9W	17	NW¼ of NW¼	
El Medano	Windmill	9N	9W	5	NW¼ of NE¼	
Las Ventanas	Windmill	9N	9W	29	NE¼ of NE¼	
Section 7	Windmill	9N	10W	7	NW¼ of SE¼	
Section 33	Windmill	9N	10W	33	NW¼ of NW¼	
Cebollita	Windmill	8N	10W	24	NE¼ of NE¼	
Pilanes	Windmill	8N	10W	26	NW¼ of SE¼	
East	Windmill	7N	11W	2	SW¼ of NW¼	
Section 21	Windmill	7N	12W	21	SW¼ of SE¼	
Brights Well	Well	8N	11W	6	SW¼ of NE¼	
Little Hole in the Wall	Tank	8N	11W	14	NE¼ of SW¼	

Water sources located in the Malpais (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Arrosa Ranch	Windmill	8N	11W	4	NW$\frac{1}{4}$ of SE$\frac{1}{4}$	
Malpais	Windmill	6N	11W	2	NW$\frac{1}{4}$ of SE$\frac{1}{4}$	
Section 29	Windmill	6N	12W	29	NE$\frac{1}{4}$ of NE$\frac{1}{4}$	
Point	Windmill	6N	11W	34	NW$\frac{1}{4}$ of NW$\frac{1}{4}$	
North Pasture	Tank	6N	11W	12	NE$\frac{1}{4}$ of NW$\frac{1}{4}$	
North	Windmill	7N	10W	20	NW$\frac{1}{4}$ of SE$\frac{1}{4}$	
	Earthen stock tank	8N	10W	34		Series of tanks along edge of Malpais.

Appendix 16

A plant list from the Ladron Mountains

Shrubs and trees

Scientific Name	Common name
Artemisia filifolia	Sand sage
Artemisia frigida	Estafiate
Atriplex canescens	Fourwing saltbush
Berberis haematocarpa	Algerita
Cercocarpus montanus	Mountain mahogany
Chrysothamnus nauseosus	Rabbit-brush
Ephedra trifurca	Mormon tea
Eurotia lanata	Winter fat
Fallugia paradoxa	Apache plume
Fendlera rupicola	Cliff fendlerbush
Gutierrezia sarothrae	Snakeweed
Juniperus monosperma	One seed juniper
Lycium pallidum	Wolf-berry
Nolina microcarpa	Sacahuista
Opuntia spp.	Prickly pear cactus
Pinus edulis	Piñon pine
Pinus ponderosa	Ponderosa pine
Populus tremuloides	Quaking aspen
Pseudotsuga menziesi	Douglas fir
Ptelea pallida	Pale leaf hoptree
Quercus gambelii	Gambel's oak
Quercus grisea	Gray oak
Rhus trilobata	Sumac
Yucca baccata	Spanish dagger
Yucca elata	Soaptree yucca

Grasses

Andropogon scoparius	Little bluestem
Aristida longiseta	Red three-awn
Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Eragrostis intermedia	Plains lovegrass
Hilaria jamesii	Galleta
Koeleria cristata	Junegrass
Muhlenbergia emersleyi	Bull grass
Muhlenbergia torreyi	Ring muhly
Panicum arizonicum	Arizona panic grass
Sporobolus flexuosus	Mesa dropseed
Stipa lettermanni	Letterman's needlegrass
Stipa neomexicana	New Mexico feathergrass
Trichachne californica	Arizona cottontop
Tridens pulchellus	Fluff grass

Appendix 16 (cont'd.)

Forbs

Baileya multiradiata	Desert marigold
Cryptantha jamesii	Nievitas
Eriogonum spp.	Buckwheat
Lepidium medium	Pepper grass
Lesquerella spp.	Bladder-pod
Mentzelia pumila	Stick-leaf
Mirabilis multiflora	Four-o'clock
Phacelia spp.	Wild heliptrope
Polonisia trachysperma	Clammy-weed
Solanum elaeagnifolium	Silver nightshade
Sphaeralcea coccinea	Globemallow
Sphaeralcea digitata	Globemallow
Verbena wrightii	Verbena

Appendix 17

Water sources located in the Ladron Mountains

Name	Type	Township	Range	Section	Location	Comments
Rain catchment unit		3N	2W	33	SW¼	
McKinley Spring	Metal stock tank	3N	3W	36	NE¼ of SE¼	Tank is 8 ft. diameter x 2 ft, situated in deep timbered canyon.
Rain catchment unit		2N	2W	7	SW¼ of SW¼	Located 7,480 ft. on summit of narrow N-S ridge, SW of main mtn. range; close proximity of trough from exclosure might limit bighorn use. NE portion of collecting basin ripped. Access road from west rough and steep.
Middle Spring	Metal stock tank	2N	2W	20		In Tres Ojitos Canyon; developed spring consisting of 6-ft. diameter x 1.5 ft. tank. Located on W-facing slope, underneath grove of juniper trees, making it difficult to locate. A second spring is located to the SE, next to the house (used as a cow camp). Access is available across Rio Salado from Silver Creek Canyon. Water is piped approx. 3/4 mile to tank. Plastic pipe broken in different places, therefore tank was receiving no water.
Stock Tank	Earthen	2N	2W	15	NW¼ of NE¼	
Stock Tank	Earthen	2N	2W	22	NE¼ of NW¼	
	Windmill	3N	2W	20	NE¼ of NE¼	

Water sources located in the Ladron Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
	Windmill	3N	2W	26	NW¼ of NW¼	
Goat Camp	Spring	3N	2W	22	NW¼ of NW¼	Natural spring. Water seeps out at 3 spots along 300 m. open slope on west. Rockhouse and corral ruins nearby.
Canon del Norte Spring	Metal stock tank	3N	3W	25	NW¼ of SE¼	In Alamito Canyon. Tank is 6 ft. dia. x 1.5 ft. located in mixed pine-oak forest within a side canyon.
Don Ignacio	Spring	3N	3W	25	NW¼ of SE¼	Fences surround drinking tanks, source would probably not receive use by bighorn.
	Seep	3N	2W	34	SW¼	
Rio Salado		2N	3W	25		
Rio Salado		2N	3W	36		

Appendix 18

Plant List from the Florida Mountains

Trees, shrubs, and half-shrubs

Scientific Name	Common Name
Acacia constricta	Mescat-acacia
Acacia greggii	Catclaw-acacia
Agave parryi	Parry agave
Aloysia wrightii	Spice bush
Aniscanthus thurberi	Desert-honeysuckle
Aplopappus laricifolius	Turpentine bush
Artemisia bigelovi	Bigelow sagebrush
Atriplex canescens	Fourwing saltbush
Berberis haematocarpa	Red mahonia
Brickellia californica	Brickellbush
Brickellia scabra	Brickellbush
Calliandra eriophylla	Calliandra
Cassia lindheimeriana	Senna
Celtis reticulata	Hackberry
Cercocarpus breviflorus	Mountain mahogany
Chilopsis linearis	Desert willow
Dasylirion wheeleri	Wheeler sotol
Echinocereus sp.	Hedgehog cactus
Ephedra trifurca	Mormon tea
Eriogonum abertianum	Buckwheat
Eriogonum wrightii	Buckwheat
Eriogonum sp.	Buckwheat
Fallugia paradoxa	Apache plume
Fendlera rupicola	Cliff fendlerbush
Ferocactus wislizeni	Southwest barrel cactus
Fouquieria splendens	Ocotillo
Garryi wrightii	Wright's silktassel
Gutierrezia microcephala	Snakeweed
Juglans major	Arizona walnut
Juniperus monosperma	One-seed juniper
Krameria parvifolia	Range ratany
Larrea tridentata	Creosote bush
Mammillaria sp.	Pincushion cactus
Morus microphylla	Texas mulberry
Nolina microcarpa	Sacahuista
Opuntia engelmannii	Prickly pear cactus
Opuntia imbricata	Cholla
Parthenium incanum	Mariola parthenium
Phoradendron coryae	Mistletoe
Phoradendron juniperinum	Mistletoe
Pinus edulis	Piñon pine
Prosopis juliflora	Mesquite
Ptelea angustifolia	Hop tree

Appendix 18 (cont'd.)

Trees, shrubs, and half shrubs (cont'd.)

Quercus arizonica	Arizona white oak
Quercus gambelii	Gambel oak
Quercus turbinella	Shrub live oak
Rhus microphylla	Small-leaf sumac
Rhus trilobata	Skunkbrush sumac
Salix sp.	Willow
Salvia pinguifolia	Sage
Sphaeralcea sp.	Globemallow
Tecoma stans	Trumpet bush
Trixis californica	Trixis
Vitis arizonica	Canyon grape
Yucca baccata	Blue yucca
Yucca elata	Soaptree yucca

Grasses

Andropogon barbinodis	Cane bluestem
Aristida divericata	Poverty three-awn
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua hirsuta	Hairy grama
Heteropogon contortus	Tanglehead
Hilaria mutica	Tobosa grass
Leptoloma cognatum	Fall witchgrass
Lycurus phleoides	Wolftail
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia montana	Mountain muhly
Muhlenbergia porteri	Bush muhly
Panicum obtusum	Vine mesquite
Poa bigelovii	Bigelow bluegrass
Seteria macrostachya	Plains bristlegrass
Sitanion hystrix	Squirreltail
Trichachne californica	Arizona cottontop
Tridens pulchellus	Fluffgrass

Forbs

Allonia incarnata	Trailing four-o-clock
Allium macropetalum	Wild onion
Aster hirtifolius	Baby aster
Astragalus tephrodes	Locoweed
Baileya multiradiata	Desert marigold
Castilleya integra	Wholeleaf painted cup
Chrysopsis sp.	Golden aster
Cirsium ochrocentrum	Thistle

Appendix 18 (cont'd.)

Forbs (cont'd.)

Commelina erecta	Dayflower
Cucurbita foetidissima	Buffalo gourd
Datura meteloides	Sacred datura
Delphinium virescens	Larkspur
Descurainia sp.	Tansy mustard
Engelmannia pinnatifida	
Erigeron divergens	Fleabane
Erodium cicutarium	Alfileria
Erysimum capitatum	Western wallflower
Eschscholtzia mexicana	Mexican goldpoppy
Haploppus gracilis	Goldenweed
Ipomopsis macombii	Gilia
Iva ambrosiaefolia	Marsh elder
Janusia gracilis	Janusia
Kallstroemia grandiflora	Arizona poppy
Lappula redowskii	Stickseed
Lepidium purpurea	Pepper grass
Lepidium thurberi	Pepper grass
Lesquerella sp.	Bladderpod
Lotus neomexicanus	Deer vetch
Malacothryx fendleri	Malacothryx
Mentzelia pumila	Stickleaf
Oenothera albicaulis	Evening primrose
Penstemon bridgesii	Bridges penstemon
Penstemon fendleri	Beardtongue
Phacelia crenulata	Phacelia
Phacelia popei	Scorpion weed
Polanisia uniglandulosa	
Psilostrophe sparsiflora	Paperflower
Psoralea tenuiflora	Scurfpea
Senecio longilobus	Groundsel
Solanum elaeagnifolium	White horse nettle
Tidestroma sp.	Tidestroma
Verbena sp.	Verbena
Viguiera sp.	

Appendix 19

Water Sources - Florida Mountains

Name	Type	Location	Remarks
South Canyon Spring		SW¼ of NW¼ of S-14, T 26S, R 8W	
Buena Vista Dam		SW¼ of NE¼, S-9, T 26S, R8W	
Crawford Tank		NW¼ of SE¼ of S-4, T 26S, R 8W	
Indian Spring		SE¼ of NE¼, S-23, T 25S, R 8W	
Mahoney Park Windmill		SW¼ of SE¼, S-26, T 25S, R 8W	
Devil's Den Dam and Tank		SE¼ of NW¼, S-2, T 26S, R 8W	
No Name Spring		NW¼ of NW¼, S-25, T 25S, R 8W	
N.M. Game and Fish Water Catchment Unit		NE¼ of SW¼, S-24, T 25S, R 8W	
Grapevine Spring		SW¼ of S-30, T 25S, R 7W	Developed; fenced in, feeds two concrete troughs; good location.
Copper Kettle Windmill		SE¼ of NE¼ of S-13, T 26S, R 7W	Permanent water - good location.
Ammo Box Spring		SW¼ of NW¼ of S-12, T 26S, R 7W	Developed, but filled with rubble. Little flow; yearlong; good location.
Corner Windmill		NE¼ of NW¼ of S-20, T 26S, R 7W	
Byer Spring		Location unsurveyed	Year-round source - flowing spring that comes from a small shaft in a canyon bottom. Developed water is piped to two concrete troughs.
Lover's Leap Spring		NE¼ of SW¼ of S-12, T 25S, R 8W	Permanent; developed by CCC, but needs repairs; good location.
Copper Queen Seep		SE¼ of SE¼ of S-14, T 25S, R 8W	

Appendix 20

A partial plant list from the West Potrillo Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Acacia constricta	White thorn
Atriplex canescens	Fourwing saltbush
Condalia spp.	
Dalea formosa	Feather dalea
Dasylirion wheeleri	Sotol
Echinocactus spp.	
Ephedra viridis	Mormon tea
Flourensia cernua	Tar-bush
Fouquieria splendens	Ocotillo
Koeberlinia spinosa	Spiny allthorn
Larrea tridentata	Creosote bush
Opuntia engelmanni	Prickly pear cactus
Opuntia spinosior	Cholla
Parthenium incanum	Mariola
Prosopis juliflora	Common mesquite
Yucca elata	Soaptree yucca

Grasses

Aristida spp.	Threeawn
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua hirsuta	Hairy grama
Lycurus phleoides	Wolftail
Setaria macrostachya	Plains bristlegrass
Sporobolus spp.	Dropseed

Forbs

Baileya multiradiata	Desert marigold
Croton spp.	
Eriogonum hieracifolium	Wild buckwheat
Eriogonum wrightii	Wild buckwheat
Linum lewisii	Blue flax
Notholaena sinuata	Wavy-leaf cloakfern
Tragia spp.	Nose-burn
Verbesina encelioides	Crownbeard
Viguiera annua	

Appendix 21

Water sources located in the West Potrillo Mountains

Name	Type	Township	Range	Section	Location	Comments
West Tub	Windmill	26S	4W	14	NW¼ of SW¼	Source is 5-9 mi. from area evaluated. Therefore, only 50% of that assigned for West Tub was assigned for Tool V water source. Windmill new, yellow and blue. Water stored in large steel tank 30 ft. dia. x 10 ft. Drinking basin enclosed in corral.
Biggs	Well	25S	4W	22	NW¼ of NW¼	Electric pump, water stored in large self-contained round metal tank. Metal corral surrounds water source.
	Earthen stock tank	25S	3W	36	SE¼ of NW¼	Tank was dry on 1-21-78.
Swale	Windmill	25S	4W	27	SE¼ of NW¼	Located between 2 and 4 miles west in flat terrain. Water stored in upright, metal tank. Drinking trough concrete and unfenced, old shack nearby.
	Metal stock tank	26S	3W	10	SW¼ of NE¼	Tank enclosed within corral. Water is piped from storage tank, located on hilltop 2 miles NE.

Water sources located in the West Potrillo Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
	Earthen stock tank	26S	3W	2		Tank had muddy bottom 1-21-78.
White Flats	Windmill	24S	4W	25	SW¼ of NW¼	Electric pump enclosed in large metal container. Water stored in large metal tank, 50 ft. dia. x 7 ft.
OD	Windmill	25S	4W	10		Drinking basin enclosed within corral.
Cox Tank	Earthen tank	27S	3W	24	SE¼ of NE¼	On NW side of Mt. Riley. Tank contained water on 1-21-78, enclosed within large corral, located at base of small, rocky hill, 193 ft. high. Water is between 5 and 8 miles away, therefore only 50% of the total points allocated for Tool V for Cox Tank was assigned.

Appendix 22

A partial plant list from the Cooke Range

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Acacia greggii	Catclaw
Agave parryi	Mescal
Atriplex canescens	Fourwing saltbush
Celtis reticulata	Net-leaf hackberry
Chilopsis linearis	Desert willow
Dalea formosa	Feather dalea
Dasylirion wheeleri	Sotol
Ephedra trifurca	Joint-fir
Eurotia lanata	Winter-fat
Fallugia paradoxa	Apache plume
Fendlera rupicola	Cliff fendlerbush
Flourensia cernua	American tarbush
Fouquieria splendens	Ocotillo
Juniperus deppeana	Alligator juniper
Juniperus monosperma	Oneseed juniper
Juniperus spp.	Juniper
Larrea tridentata	Creosote bush
Lycium pallidum	Pale wolfberry
Mammillaria sp.	Pincushion cactus
Mimosa biuncifera	Mimosa
Morus microphylla	Texas mulberry
Nolina microcarpa	Sacahuista
Opuntia engelmanni	Prickly pear cactus
Opuntia spinosior	Cholla
Parthenium incanum	Mariola
Pinus edulis	Piñon pine
Prosopis juliflora	Common mesquite
Ptelea pallida	Pale hoptree
Quercus spp.	Oak
Rhus microphylla	Little-leaf sumac
Rhus trilobata	Skunk-bush sumac
Rubeckia spp.	
Salvia pinguifolia	Sage
Senecio douglasii	Thread-leaf groundsel
Yucca baccata	Datil yucca
Yucca elata	Soaptree yucca

Grasses

Agropyron spicatum	Blue-bunch wheatgrass
Agropyron spp.	Wheatgrass
Andropogon saccharoides	Silver bluestem
Aristida spp.	Threeawn

Appendix 22 (cont'd.)

Grasses (cont'd.)

Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Bromus catharticus	Brome
Chloris spp.	
Distichlis sp.	Salt grass
Hilaria mutica	Tobosa
Leptochloa dubia	Green sprangletop
Lycurus phleoides	Wolftail
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia porteri	Bush muhly
Muhlenbergia rigens	Deergrass
Muhlenbergia sp.	Muhly
Panicum arizonicum	Arizona panic grass
Sitanion hystrix	Squirrel-tail
Sporobolus spp.	Dropseed
Tridens mutica	Slim tridens
Tridens pulchellus	Fluffgrass
Tridens spp.	Tridens

Forbs

Allionia incarnata	Trailing four o'clock
Allium rhizomatum	Wild onion
Amaranthus spp.	Amaranth
Aplopappus spp.	
Artemisia filifolia	Sand sage
Astragalus spp.	Milk vetch
Baileya multiradiata	Desert marigold
Chenopodium spp.	Goose-fat
Cirsium spp.	Thistle
Croton spp.	Leather weed
Eriogonum spp.	Wild buckwheat
Gilia spp.	
Gutierrezia sarothrae	Broom snakeweed
Hedeoma drummondi	Mock pennyroyal
Hoffmanseggia densiflora	Hog potato
Lesquerella purpurea	Bladder-pod
Melampodium leucanthum	Blackfoot daisy
Mentzelia pumila	Stick-leaf
Mirabilis multiflora	Four o'clock
Notholaena sinuata	Wavy-leaf cloakfern
Oenethera spp.	Evening primrose
Oxalis sp.	Wood sorrel
Penstemon barbatus	Beard tongue
Phacelia corrugata	

Appendix 22 (cont'd.)

Forbs (cont'd.)

Psilostrophe tagetina	Paper flower
Salsola kali	Russian thistle
Senecio douglasi	Groundsel
Solanum elaeagnifolium	White horse-nettle
Solidago spp.	Goldenrod
Sphaeralcea spp.	Globemallow
Thelesperma longipes	Cota
Tragia nepetaefolia	Nose-burn
Verbena wrightii	Vervain
Verbesina encelioides	Crownbeard
Zinnia grandiflora	Zinnia

Appendix 23

Water Sources - Cooke Range

Name	Type	Location	Remarks
Prospect Springs		NW¼ of SW¼ of S-11, T 21S, R 9W	
Provinger Tank	Metal tank	S-34, T 20S, R 9W	
Unnamed	Windmill	NE¼ of SW¼ of S-3, T 20S, R 9W	
Butterfield Well		Section line between S-16 and S-17, T 21S, R 9W	
Hyatt Tank	Earthen tank	SW¼ of S-14, T 21S, R 8W	
Oil Well Windmill		NW¼ of NW¼ of S-18, T 21S, R 9W	
Frying Pan Spring		SW¼ of SE¼ of S-20, T 21S, R 8W	
Hinard Windmill		NE¼ of SW¼ of S-9, T 21S, R 8W	
Starvation Draw Detention Dam #3	Earthen dam	Section line between S-19 and S-30, T 21S, R 8W	
Cooke Spring		NW¼ of SW¼ of S-23, T 21S, R 8W	
Rattlesnake Spring		S-6, T 21S, R 8W	Located within Rattlesnake Canyon.
Unnamed	Windmill	NW¼ of SE¼ of S-32, T 19S, R 8W	
Unnamed	Windmill	S-15, T 20S, R 9W	Windmill (eventually) feeds a large (50 x 6 ft.) metal stock tank. Water is then piped into a concrete trough (15 x 2 x 15 ft.).
South Fork Provinger Canyon Spring		S-2, T 21S, R 9W	

Water Sources - Cooke Range (cont'd.)

Name	Type	Location	Remarks
Unnamed	Seep	SE¼ of SE¼ of S-26, T 20S, R 9W	
OK Canyon Seep #1		S-36, T 20S, R 9W	Located in the OK Canyon Drainage.
OK Canyon Seep #2		S-36, T 20S, R 9W	Located in the OK Canyon Drainage.
Provinger Canyon Seep		S-36, T 20S, R 9W	Within Main Provinger Canyon, water seeps out at several places. Two metal stock tanks within the main canyon are fed from the spring.
North Provinger Seep		S-35, T 20S, R 9W	
Unnamed	Earthen tank	S-1, T 20S, R 9W	A non-functional windmill is present.
Clark Draw Tank		S-1, T 20S, R 9W	
South Fork Provinger Seep		S-3, T 21S, R 9W	
Unnamed	Windmill	S-23, T 20S, R 9W	The windmills (one is non-functional) pump water into a large metal stock tank (15 x 2 ft.) about 75 feet away.
Burro Spring		S-31, T 19S, R 8W	
Alkali Spring		S-29, T 19S, R 8W	
North OK Canyon Spring		S-31, T 20S, R 8W	
Shale Spring		NW¼ of SW¼ of S-29, T 20S, R 8W	
Unnamed	Windmill	SE¼ of NW¼ of S-17, T 20S, R 8W	
Unnamed	Windmill	SW¼ of SE¼ of S-7, T 20S, R 8W	
Walnut Spring		NW¼ of NW¼ of S-6, T 20S, R 8W	

Water Sources - Cooke Range (cont'd.)

Name	Type	Location	Remarks
Riley	Spring	S-24, T 20S, R 9W	An earthen tank is located just north of a miner's shack. Riley Spring water is piped into metal stock tanks (5 x 1.5 ft. deep).
Unnamed well	Windmill	S-13, T 20S, R 9W	Windmill is submergible type; has nearby stock tank.

Appendix 14

A partial list of plants identified from the Burro-Gila Middle Box

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Acacia constricta	White thorn
Acacia greggi	Catclaw
Agave palmeri	Mescal
Aloysia wrightii	Spicebush
Aplopappus laricifolius	Turpentine bush
Atriplex canescens	Fourwing saltbush
Baccharis brachphylla	
Baccharis glutinosa	Seep willow
Calliandra eriophylla	False mesquite
Carlowrightia linearifolia	
Cassia bauhinioides	Senna
Ceanothus greggi	Desert ceanothus
Cercocarpus montanus	Mountain mahogany
Chilopsis linearis	Desert willow
Chrysothamnus nauseosus	Rabbit-brush
Condalia lyciodes	Gray thorn
Condalia spathulata	Squaw bush
Dalea albiflora	
Dalea formosa	Feather plume
Dalea nana	Dwarf dalea
Dalea pogonothera	
Dalea terminalis	
Dalea wrightii	
Dasylirion wheeleri	Sotol
Echinocereus fasciculatus	
Ephedra trifurca	Jointfir
Eurotia lanata	Winter fat
Fendlera rupicola	Cliff fendlerbush
Ferocactus wislizeni	Barrel cactus
Fouquieria splendens	Ocotillo
Fraxinus velutina	Velvet ash
Gutierrezia sarothrae	Broom snakeweed
Janusia gracilis	
Juniperus monosperma	One seed juniper
Larrea tridentata	Creosote bush
Lycium pallidium	Pale wolfberry
Mammilaria aggregata	Pincushion cactus
Mammilaria gummifera	
Mimosa biuncifera	Mimosa
Morus microphylla	Texas mulberry
Nolina microcarpa	Sacahuista
Opuntia chlorotica	Silver-dollar cactus
Opuntia engelmanni	Prickly pear cactus
Opuntia leptocaulis	Christmas cactus

Appendix 24 (cont'd.)

Trees, shrubs, half-shrubs (cont'd.)

Opuntia phaeacantha	
Opuntia spinosior	Cholla cactus
Opuntia violacea	Purple prickly pear cactus
Parthenium incanum	Mariola
Pinus edulis	Pinon pine
Platanus wrighti	Arizona sycamore
Populus fremonti	Freemont cottonwood
Prosopis juliflora	Common mesquite
Quercus arizonica	Arizona white oak
Quercus grisea	Gray oak
Quercus turbinella	Shrub liveoak
Rhus trilobata	Skunk-bush sumac
Salix sp.	Willow
Salvia columbariae	Sage
Tamarix gallica	Tamarisk
Viguiera stenoloba	Resin bush
Yucca baccata	Datil yucca

Grasses

Andropogon barbinodis	
Aristida glauca	
Aristida longiseta	Red threeawn
Aristida purpurea	Purple three-awn
Aristida ternipes	Spider grass
Bouteloua aristidoides	Needlegrass
Bouteloua barbata	Six-weeks grama
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Bouteloua rockrothii	Rockroth grama
Eragrostis arida	Love grass
Eragrostis cilianensis	Love grass
Festuca octoflora	Fescue
Heteropogon contortus	Tanglehead
Hilaria belangeri	Curly mesquite
Hilaria jamesii	Galleta
Hilaria mutica	Tobosa
Leptochloa dubia	Green sprangletop
Lycurus phleoides	Wolftail
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia porteri	Bush muhly
Muhlenbergia rigens	Deer grass
Panicum hallii	Panic grass
Panicum hirticaule	Panic grass
Plantago purshii	Indian wheat

Appendix 24 (cont'd.)

Grasses (cont'd.)

Setaria macrostachya	Plains bristlegrass
Sitanion hystrix	Bottlebrush
Sporobolus cryptandrus	Sand dropseed
Sporobolus texanus	Dropseed
Trichachne californica	Cottontop
Tridens muticus	Slim tridens
Tridens pulchellus	Fluff grass

Forbs

Allionia incarnata	Trailing-four-o'clock
Allium acuminatum	Onion
Amaranthus palmeri	Careless weed
Ambrosia artemesiifolia	Short ragweed
Ammocodon chenopodioides	Goosefoot moonpod
Amnosia longiflora	Blue-star
Anemone tuberosa	Wind-flower
Anisacanthus thurberi	Desert-honeysuckle
Aplopappus tenuisectus	Burro-weed
Argemone platyceras	Chicalote
Aristolochia watsoni	Indian-root
Artemesia dracunuloides	False-tarragon
Artemesia gnaphalodes	Sagebrush
Asclepias erosa	Desert milkweed
Astragalus nuttiallianus	Loco-weed
Astragalus wootonii	Garbancillo
Bahia absinthifolia	
Baileya multiradiata	Desert marigold
Boerhaavia coccinea	Scarlet spiderling
Calochortus nuttallii	Sego lily
Calycoseris wrightii	White cup-fruit
Calyptridium monandrum	
Cevallia sinuata	
Chamaesaracha conoides	False-nightshade
Chenopodium fremontii	Goose-foot
Chenopodium sp.	
Cirsium neomexicanum	Thistle
Commicarpus scandens	Climbing wartclub
Conyza canadensis	Horse-weed
Corydalis aurea	Scrambled eggs
Croton texensis	Dove-weed
Cryptantha sp.	
Cucurbita sp.	
Datura meteloides	Sacred datura
Daucus pusillus	Rattlesnake-weed
Delphinium virescens	Larkspur
Descurainia obtusa	Tansy-mustard

Appendix 24 (cont'd.)

Forbs (cont'd.)

Descurainia pinnata	Tansy-mustard
Eriastrum diffusum	
Erigeron concinnus	Wild daisy
Eriodium cicutarium	Heron-bill
Eriogonum abertianum	Wild buckwheat
Eriogonum spp.	
Eriogonum wrightii	Wild buckwheat
Eschscholtzia mexicana	Gold poppy
Euphorbia albomarginata	Spurge
Euphorbia cinerascens	Spurge
Evolvulus arizonicus	
Evolvulus sericeus	
Gilia sinuata	
Gilia sp.	
Gnaphalium sp.	
Gutierrezia sarothrae	Broom snakeweed
Helianthus sp.	Sunflower
Hibiscus denudatus	Rosemallow
Ipomopsis longiflora	
Ira ambrosiaefolia	Marsh elder
Lepidium lasiocarpum	Pepper-grass
Lepidium medium	Pepper-grass
Lepidium thurberi	Pepper-grass
Lescurella gordoni	Bladder-pod
Leucelene ericoides	White aster
Lotus humistratus	Deer-vetch
Lotus neomexicanus	Deer-vetch
Lupinus concinnus	Lupine
Lupinus sparsiflorus	Lupine
Machaeranthera gracilis	
Machaeranthera tanacetifolia	Tahoka daisy
Malacothrix fendleri	
Maurandya antirrhiniflora	Snapdragon vine
Mentzilia pumila	Stick leaf
Microseris linearifolia	
Mirabilis multiflora	Four o'clock
Monnina wrightii	
Nicotiana trigonophylla	Tobacco
Notholaena sinuata	Wavy cloakfern
Oenothera primaveris	Evening primrose
Orobanche ludoviciana	Broom-rape
Pellaea longimucronata	Cliff brake
Penstemon barbata	Beardtongue
Penstemon subulatus	Beardtongue
Perezia nana	Desert holly
Perezia wrightii	Brownfoot
Phacelia crenulata	
Phacelia neomexicana	
Physalis fendleri	Ground cherry

Appendix 24 (cont'd.)

Forbs (cont'd.)

Physalis hederaefolia	Ground cherry
Polanisia dodecandra	Clammy weed
Portulaca oleracea	Common purslane
Portulaca suffrutescens	Purslane
Proboscidea arenaria	Unicorn plant
Psilostrophe tagetina	Paper flower
Rhyncosia texana	Rosary bean
Rumex hymenosepalus	Wild rhubarb
Salsola kali	Russian thistle
Senecio longilobus	Thread-leaf groundsel
Sida filicaulis	
Sisymbrium irio	London rocket
Solanum elaeagnifolium	White horse-nettle
Solanum rostratum	Buffalo-bur
Sonchus asper	Sow thistle
Spermolepsis echinata	Scale seed
Sphaeralcea coccinea	Globemallow
Talinum angustissimum	Flame flower
Tribulus terrestris	Puncture vine
Tripterocalyx wootoni	
Verbena ciliata	Vervain
Verbesina encelioides	Crownbeard
Vicia exigua	Vetch
Xanthium strumarium	Cocklebur
Zinnia grandiflora	Zinnia
Zinnia pumila	

Appendix 25

Water Sources - Burro Mountains-Gila Middle Box

Name	Type	Location	Remarks
Gila River		Traverses study area from North to South along east boundary	No grazing; occasional visitors, recreationalists.
Foxtail Spring		SW¼ of NE¼ of S-6, T 18S, R 17W	Located where Foxtail Canyon narrows, forming a gorge. Source consists of concrete drinking trough 8 ft. x 3 ft. x 2 ft. deep; a 2-in. plastic pipe feeds trough from source (excavation underneath bank). Source is obstructed by trees and shrubs.
Unnamed	Spring	S-1, T 18S, R 18W	
Unnamed	Spring	S-4, T 18S, R 18W	
Unnamed	Spring	S-10, T 18S, R 18W	
Jacks Canyon Spring		S-15, T 18S, R 18W	
Smith Spring		S-17, T 18S, R 18W	
Unnamed	Series of 4 springs	S-29, T 16S, R 19W	Located within Spring Canyon.
Clyde Spring		SW¼ of NW¼ of S-10, T 18S, R 18W	
High Lonesome Spring		SE¼ of NE¼ of S-25, T 17S, R 19W	
Unnamed	Spring	S-7, T 17S, R 17W	Located within brushy canyon bottoms.
Unnamed	Spring	S-8, T 17S, R 17W	Located within brushy canyon bottoms.
Unnamed	Spring	S-18, T 17S, R 17W	Located within brushy canyon bottoms.

Water Sources - Burro Mountains-Gila Middle Box (cont'd.)

Name	Type	Location	Remarks
Unnamed	Spring	S-20, T 17S, R 17W,	Located within brushy canyon bottoms.
Unnamed	Spring	S-24, T 17S, R 18W	Located within brushy canyon bottoms.
Grapevine Spring		SW¼ of NE¼ of S-18, T 17S, R 17W	Cattle grazing.
Elephant Back Mountain	Spring	SE¼ of NE¼ of S-29, T 17S, R 18W	
Unnamed	Spring	S-22, T 17S, R 18W	
Unnamed	Spring	S-25, T 17S, R 18W	
Unnamed	Spring	S-26, T 17S, R 18W	
Unnamed	Spring	S-27, T 17S, R 18W	
Unnamed	Spring	S-29, T 17S, R 18W	
Unnamed	Spring	S-30, T 17S, R 18W	
Unnamed	Spring	S-33, T 17S, R 18W	
Unnamed	Spring	S-36, T 17S, R 18W	
Unnamed	Earthen Stock Tank	NE¼ of SE¼ of S-34, T 17S, R 18W	
Unnamed	Earthen Stock tank	SE¼ of NW¼ of S-32, T 17S, R 18W	
Slate Creek Camp	Spring	SE¼ of NE¼ of S-2, T 18S, R 18W	

Appendix 26

A partial list of plants from the Alamo Hueco Mountains

Trees, shrubs, and half-shrubs

Scientific Name	Common Name
Acacia constricta	White thorn
Acacia greggi	Catclaw
Agave palmeri	Mescal
Bumelia laniginosa	Gum bumelia
Celtis reticulata	Netleaf hackberry
Chrysothamnus puchellus var. *baileyi*	Rabbit-brush
Ephedra spp.	Joint fir
Fallugia paradoxa	Apache plume
Fouquieria splendens	Ocotillo
Gutierrezia spp.	Snakeweed
Haplopappus larciflorus	Turpentine bush
Juniperus deppeana	Alligator juniper
Lippia wrighti	Wright lippia
Mammillaria gummifera	Fishhook cactus
Microrhamnus ericoides	Javelina-brush
Nolina spp.	Bear-grass
Opuntia engelmanni	Prickly pear cactus
Opuntia leptocaulis	Desert Christmas cactus
Parthenium incanum	Mariola
Platanus wrightii	Arizona sycamore
Prosopis juliflora	Common mesquite
Quercus spp.	Oak
Rhus microphylla	Little-leaf sumac
Rhus trilobata	Skunk-bush sumac
Yucca baccata	Datil yucca
Yucca schottii	Hoary yucca

Grasses

Scientific Name	Common Name
Andropogon saccharoides	Silver blue-stem
Aristida spp.	Threeawn
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Eragrostis spp.	Love grass
Hilaria jamesii	Galleta
Lycurus phleoides	Wolf-tail
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia rigens	Deergrass
Panicum obtusum	Vine mesquite
Setaria macrostachya	Plains bristlegrass
Sitanion hystrix	Squirrel-tail

Appendix 26 (cont'd.)

Grasses (cont'd.)

Sporobolus spp.	Dropseed

Forbs

Eriogonum spp.	Wild buckwheat
Notholaena spp.	Cloakfern
Solanum spp.	Nightshade
Sphaeralcea spp.	Globemallow

Appendix 27

Water Sources - Alamo Hueco Mountains

Name	Type	Location	Remarks
Upper Sycamore Tank	Earthen	SE¼ of NE¼ of S-2, T 34S, R 15W	2,600 Animal Unit Months allowed by permit. However, mountain has been rested for three years. Cattle grazed in Horse Canyon, Dog Spring and NW Tank (N of Wood Canyon).
Section 32 Windmill		S-32, T 33S, R 15W	
Stone Cabin Tank	Earthen	NE¼ of SW¼, S-29, T 33S, R 15W	
Horse Canyon Windmill		NW¼ of NW¼ of S-34, T 33S, R 15W	
Thicket Spring		NW¼ of SW¼ of S-23, T 33S, R 15W	
NW Tank	Earthen	SW¼ of SW¼ of S-30, T 32S, R 15W	NW Tank is located at the end of U-bar Ridge.
Section 3 Windmill		NW¼ of SE¼ of S-3, T 34S, R 15W	
Unnamed	Earthen Stock Tank	NW¼ of SW¼ of S-33, T 33S, R 15W	
Sycamore Well		SW¼ of SW¼ of S-31, T 33S, R 14W	
Dry Tank	Earthen	SW¼ of SE¼ of S-19, T 33S, R 14W	
Cottonwood Spring		NW¼ of SW¼ of S-24, T 33S, R 15W	
Unnamed	Earthen Tank	NW¼ of SW¼ of S-22, T 33S, R 15W	
Upper Horse Tank	Earthen	NW¼ of SW¼ of S-14, T 33S, R 15W	
Pierce Canyon Seep #1		S-11, T 33S, R 15W	

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Water Sources - Alamo Hueco Mountains (cont'd.)

Name	Type	Location	Remarks
Pierce Canyon	Seep	S-11, T 33S, R 15W	
McFarlands Well	Windmill	NW¼ of NW¼ of S-1, T 33S, R 15W	
Petersons Well	Windmill	SE¼ of NW¼ of S-1, T 33S, R 14W	
Jensen Wells	Windmill	NE¼ of SE¼ of S-17, T 33S, R 14W	
Section 21 Tank	Windmill and Storage Tank	SW¼ of SE¼ of S-21, T 33S, R 14W	Located at road intersection along fenceline, and within a corral.
Hat Top Tank	Metal Tank	SW¼ of SE¼ of S-27, T 33S, R 14W	Water is piped from windmill over a mile away and is stored in closed upright metal tank. Concrete trough (10 ft. x 1.5 ft. x 3 ft. wide) is situated about 50 ft. from tank.
Dog Springs	Windmill, Stock Tank	SW¼ of NW¼ of S-13, T 34S, R 15W	Stock Tank located within corral. Frequent cattle use.

Appendix 28

A partial list of plants from the Big Hatchet Mountains

AMARANTHACEAE

- *Tidestromia lanuginosa*

AMARYLLIDACEAE

- *Agave schottii*
  - *parryi*
  - *palmeri*

ANACARDIACEAE

- *Rhus microphylla*
  - *trilobata* (Skunkbush)
  - *choriophylla*

ASCLEPIADACEAE

- *Funastrum crispum* (Climbing milkweed)

- *Asclepias angustifolia* (Milkweed)
  - *latifolia* (Milkweed)

BIGNONIACEAE

- *Chilopsis linearis* (Desert willow)

BORAGINACEAE

- *Lappula redowskii* (Stick weed)
  - *texana* (Stick weed)

- *Lithospermum incisum* (Gromwell)

CACTACEAE

- *Coryphantha scheeri* (Nipple cactus)
  - *vivipara* (Nipple cactus)
  - *strobiliformis* (Nipple cactus)

- *Echinocereus fendleri* (Hedgehog cactus)
  - *pectinatus*
    - var. *rigidissimus* (Arizona rainbow cactus)
    - var. *neomexicanus* (Yellow flowered hedgehog cactus)
  - *triglochidiatus* (Red flowered hedgehog cactus)

- *Ferocactus wislizeni* (Barrel cactus)

- *Mammillaria gummifera* (Chile pepper cactus)
  - *grahamii*
  - *wrightii*

- *Neolloydida intertexta*

Appendix 28 (cont'd.)

- *Opuntia spinosior* (Cane cholla)
  - *phaeacantha*
    - var. *phaeacantha* (Prickly pear)
  - *discata* (Prickly pear)
  - *chlorotica* (Pancake pear)
  - *violacea* (Purple prickly pear)
    - var. *santa rita* (Purple prickly pear)
  - *macrorhiza* (Plains prickly pear)
  - *leptocaulis* (Desert Christmas cactus)

- *Peniocereus greggii* (Night-blooming cereus)

CAPPERACEAE
- *Polanisia trachysperma* (Clammy weed)

CELASTRACEAE
- *Glossopetalon spinescens* (Grease bush)

CHENOPODIACEAE
- *Atriplex canescens* (Fourwing saltbush, chamiso)
  - *acanthocarpa* (Saltbush)

- *Eurotia lanata* (Winter fat)

- *Salsola kalli* (Russian thistle)

COCHLOSPERMACEAE
- *Amoreuxia palmatifida*

COMPOSITAE
- *Ambrosia psilostachya* (Ragweed)

- *Aster tanacetifolius*

- *Bahia dissecta* (Yellow ragweed)

- *Baileya pleniradiata* (Desert marigold)
  - *multiradiata* (Desert marigold)

- *Brickellia* sp.

- *Erigeron neomexicanus* (Fleabane)
  - *divergens* (Fleabane)

- *Flourensia cernua* (Tar bush)

- *Gaillardia pulchella* (Fire wheel, Indian basket)

- *Gnaphalium wrightii*

Appendix 28 (cont'd.)

Gutierrezia linoides (Snakeweed)
sarothrae (Snakeweed)

Haplopappus spinulosus
laricifolius (Turpentine bush)
gooddingii

Helianthus annus (Annual sunflower)

Hymenothrix wrightii

Machaeranthera tenacetifolius

Melampodium leucanthum

Parthenium incanum (Mariola)

Pectis species (Fetid marigold)
angustifolia (Fetid marigold)

Perezia nana (Desert holly)
thurberii

Psilostrophe tagetina (Paperflower)

Sanvitalia aberti

Sencio longilobus (Threadleaf groundsel)

Solidago occidentalis (Western goldenrod)

Zinnia grandiflora (Paperflower)
pumila

CONVOLVULACEAE
Ipomea leptotoma (Morning-glory)
coccinea (Star-glory)
heterophyla (Morning-glory)

CORNACEAE
Garrya wrightii (Silk tassel)

CRUCIFERAE
Arabis fendleri (Rock-cress)
perennans (Rock-cress)

Descurinia sophia (Tansy mustard)

Dithyrea californica (Spectacle-pod)

Draba cuneifolia

Appendix 28 (cont'd.)

Erysimum capitatum (Western wallflower)

Lepidum thurberi (Pepper grass)

Lesquerella gordoni (Bladder-pod)
fendleri (Bladder-pod)

CUCURBITACEAE
Apodanthera undulata (Melon loco)

Cucurbita digitata (Gourd)

Ibervillea tenuisecta

CUPRESSACEAE
Juniperus monosperma (One seed juniper)
deppeana (Alligator juniper)

EPHEDRACEAE
Ephedra trifurca (Mormon tea)

ERICACEAE
Arbutus arizonica (Manzanita)

EUPHORBIACEAE
Croton species
texensis (Dove weed)

Jatropha macrorhiza

FAGACEAE
Quercus undulata (Wavy leaf oak)
reticulata (Net leaf oak)
grisea (Grey oak)

FOUQUIERIACEAE
Fouquieria splendens (Ocotillo)

FUMARIACEAE
Corydalis aurea (Golden smoke)

GERANIACEAE
Erodium cicutarium (Cranes bill)

GRAMINEAE
Andropogon barbinodis (Blue stem, Broom-sedge)

Aristida adscensionis (Six weeks three awn)
hamulosa (Three awn)
longiseta (Three awn)
arizonica (Three awn)

Appendix 28 (cont'd.)

Bouteloua eriopoda (Black grama)
filiformis (Slender grama)
curtipendula (Sideoats)
hirsuta (Hairy grama)

Chloris virgata (Finger grass)

Enneapogon desuauxii (Australian grass)

Eragrostis diffusa (Love grasses)
intermedia (Love grasses)
cilianensis (Love grasses)

Heteropogon contortus (Tangle head)

Hilaria mutica (Tobosa grass)

Leptochloa dubia (Sprangletop)

Lycurus phleoides (Wolf tail)

Muhlenbergia arenacea (Muhly)
torreyi (Rug muhly)
porteri (Bush muhly)
monticola (Mesa muhly)

Panicum hirticaula (Witch grass)
obtusum (Vine mesquite)

Setaria macrostachya (Bristle grass)
viridia (Green bristle grass)

Sorghum halepense (Johnson grass)

Sporobolus cryptandrus (Drop seeds)
contractis (Drop seeds)

KOEBERLINIACEAE
Koeberlinia spinosa (Crown of thorns)

LABIATAE
Hedeoma dentatum (Mock-penny royal)

Scutellaris tessellata (Skull-cap)
potosina (Skull-cap)

LEGUMINOSAE
Acacia constricta (Mescat acacia, white thorn)
greggii (Catclaw acacia, devils claw)

Appendix 28 (cont'd.)

Astragalus bigelovii (Milk-vetch)
crassicarpus (Ground plum, Indian pea, Buffalo bean)

Calliandra eriophylla (False-mesquite)

Cassia wizlizeni (Senna)

Dalso formosa (Indigo-bush, Pea bush)
scoparia (Indigo-bush, Pea bush)
poganathera (Indigo-bush, Pea bush)

Plagiobothyrs arizonicus (Blood weed)

Prosopis juliflora (Mesquite)

Robinia neomexicana (Black locust)

Vicia exigua (Vetch)

LILIACEAE
Allium species (Wild onion)
macropetalum (Wild onion)

Dasylirion wheeleri (Sotol)

Dichelostemma pulchellum (Bluedicks, covena, grass-nuts)

Nolina microcarpa (Bear grass)

Yucca baccata (Mountain yucca)
elata (Soap weed)

LINACEAE
Linum lewisii (Flax)

LOASACEAE
Cervallia sinuata

Mentzelia pumilla (Stickweed)

LORANTHACEAE
Phoradendron juniperinum (Mistletoe)

MALVACEAE
Sida procumbens
lepidota

Sphaeralcea species (Globemallow)
ambigua (Desertmallow, apricotmallow)

APPENDIX 28 (cont'd.)

- MARTYNIACEAE
  - *Proboscidea parviflora* (Unicorn plant)
- NYCTAGINACEAE
  - *Allionia incarnata* (Tailing-four o'clock)
  - *Mirabilis longiflora* (Four o'clock)
- OLEACEAE
  - *Fraxinus velutina* (Velvet ash)
- ONAGRACEAE
  - *Epilobium* (Willow weed)
  - *Oenothera primaveris* (Evening primrose, sundrops)
  - *Zauschneria latifolia* (Hummingbird-trumpet)
- PAPAVERACEAE
  - *Argemone neomexicana* (Prickly poppy)
  - *Eschscholzia mexicana* (California poppy)
- PINACEAE
  - *Pinus edulis* (Piñon)
- PLATANACEAE
  - *Platanus wrightii* (Arizona sycamore)
- POLEMONIACEAE
  - *Gilia rigidula*
  - *Ipomopsis longiflora*
- POLYGONACEAE
  - *Eriogonum* (Buck wheats)
    - *alatum* (Winged eriogonum)
- POLYPODIACEAE
  - *Bommeria hispida*
- RANUNCULACAE
  - *Anemone tuberosa*
- RHAMNACEAE
  - *Ceanothus greggii* (Buck brush)
  - *Condalia spathulata* (Squaw bush)
    - *lycioides* (Gray thorn)
  - *Rhamnus* (Buck thorn)

APPENDIX 28 (cont'd.)

ROSACEAE
- *Cercocarpus montanus* (Alder-leaf mountain mahogany)
  - *brevifolius* (Mountain mahogany)
- *Fallugia paradoxa* (Apache plume)

SALICACEAE
- *Populus acuminata* (Lance-leaf cottonwood)

SAPOTACEAE
- *Bumelia lanuginosa* (Gum bumelia)

SAPINDACEAE
- *Sapindus saponaria* (Soapberry)

SAURURACEAE
- *Anemopsis californica* (Yerba-mansa)

SCROPHULARIACEAE
- *Castilleja sessiliflora* (Paint brush, painted cup)
  - *laxa* (Paint brush, painted cup)
  - *integra* (Paint brush, painted cup)
  - *lanata* (Paint brush, painted cup)
- *Penstemon barbatus* (Beards tongue)
  - *linaroides* (Beards tongue)
  - *lanceolatus* (Beards tongue)

SELAGINELLACEAE
- *Selaginella rupincola*

SOLANACEAE
- *Datura quercifolia* (Thorn apple)
  - *metaloides* (Jimson weed, sacred datura, Indian apple)
- *Lycium pallidum* (Wolfberry, desert thorn)
- *Solanum eleganifolium* (Nightshade)
  - *capitatum* (Nightshade)
  - *rostratum* (Buffalo bur)

UMBELLIFERAE
- *Lomatium nevadense* (Biscuit root, Indian root)

VERBENACEAE
- *Lippia wrightii* (Aloysia)
- *Verbena ciliata* (Vervain)
  - *wrightii* (Vervain)

APPENDIX 28 (cont'd.)

ZYGOPHYLLACEAE

Kallstroemia grandiflora (Puncture vine)

Larrea tridentata (Creosote bush)

Appendix 29

Water Sources - Big Hatchet Mountains

Name	Type	Location	Remarks
Sheep Tank		NE¼ of NW¼ of S-8, T 31S, R 15W	Situated about 1000 ft. below Big Hatchet Peak. Source consists of concrete dam structure about 30 ft. long x 8 ft. high constructed across the middle fork of the head of Thompson Canyon. On 2-16-78, pool of water was 15 ft. in diameter and a 6 in. snow cover characterized protected slopes. Area above 7,000 ft. is generally inaccessible to livestock; forage conditions appear excellent.
(W.C.U. #6)	Water Catchment Unit	SE¼ of SE¼ of S-1, T 31S, R 16W	
Ram Gorge Unit (#5)	Water Catchment Unit	SE¼ of S-19, NE¼ of S-30, T 30S, R 15W	About 40% of area is accessible to grazing due to topography.
Chainey Canyon Unit	Water Catchment Unit	SW¼ of NW¼ of S-31, T 30S, R 15W	
Witch Well	Windmill	NW¼ of SW¼ of S-6, T 30S, R 15W	
Thompson Tank	Stock Tank	NW¼ of NW¼ of S-10, T 31S, R 15W	
Thompson Canyon Unit	Water Catchment Unit	NE¼ of NE¼ of S-17, T 31S, R 15W	
Sheridan Wells	Windmill	SE¼ of NW¼ of S-23, T 31S, R 15W	Corral and dense riparian vegetation around Windmill. Frequent livestock use.
Deep Well	Windmill	NW¼ of SE¼ of S-29, T 31S, R 15W	Deep Well at mouth of New Well Canyon.
New Well Peak W.C.U.	Water Catchment Unit	NW¼ of SW¼ of S-32, T 31S, R 15W	
Sheridan Tank	Earthen	SE¼ of SW¼ of S-5, T 32S, R 15W	

Water Sources - Big Hatchet Mountains (cont'd.)

Name	Type	Location	Remarks
Mengus Tank	Metal Stock Tank	NW¼ of NW¼ of S-26, T 32S, R 15W	
Mine Canyon Tank	Earthen	NE¼ of SE¼ of S-35, T 31S, R 15W	
Mine Canyon Water Catchment Unit		SW¼ of SW¼ of S-35, T 31S, R 15W	
Little Tank	Earthen	NE¼ of SW¼ of S-20, T 31S, R 15W	
Hell-to-Finish Tank	Earthen	NW¼ of NE¼ of S-11, T 32S, R 15W	
Red Lake	Earthen	NE¼ of NE¼ of S-21, T 32S, R 15W	
Big Tank	Earthen	NE¼ of NE¼ of S-31, T 32S, R 15W	

Appendix 30

A partial plant list of the Little Hatchet Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Agave palmeri	Mescal
Agave parryi	Mescal
Aplopappus larcifolius	Turpentine bush
Celtis reticulata	Blackberry
Chilopsis linearis	Desert willow
Condalia spp.	
Dasylirion wheeleri	Sotol
Ephedra viridis	Mormon tea
Fallugia paradoxa	Apache plume
Flourensia cernua	Fragrant ash
Foucuieria splendens	Ocotillo
Gutierrezia spp.	Snakeweed
Juniperus monosperma	One seed juniper
Larrea tridentata	Creosote bush
Opuntia engelmanni	Prickly pear cactus
Opuntia imbricata	Cholla
Parthenium incanum	Mariola
Prosopis juliflora	Common mesquite
Quercus spp.	
Rhus microphylla	Little-leaf sumac
Yucca baccata	Datil yucca
Yucca elata	Soaptree yucca

Grasses

Andropogon furcatus	Big bluestem
Andropogon saccharoides	Silver bluestem
Andropogon scoparius	Little bluestem
Aristida spp.	Threeawn
Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Leptochloa dubia	Green sprangletop
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia porteri	Bush muhly
Sporobolus spp.	Dropseed
Tridens pulchellus	Fluff grass

Forbs

Astragalus spp.	Poisonvetch
Dithyrea wislizeni	Spectacle-pod
Solanum eleagnifolium	Silverleaf nightshade

Appendix 31

Water sources located in the Little Hatchet Mountains

Name	Type	Township	Range	Section	Location	Comments
Trapper	Windmill	28S	16W	22	NW¼ of NE¼	
Livermore	Windmill	28S	16W	21	NE¼ of NE¼	Located at North Gap, in gentle open terrain with escape terrain about 150 yds. to the north.
Sylvanite	Windmill	29S	16W	4	NE¼ of NW¼	
Howell's Wells	Wells	28S	16W	24	NW¼ of NE¼	
Cottonwood	Spring	28S	16W	33	NW¼ of NW¼	Water piped from source (tunnel) to concrete trough. Source surrounded by cottonwood, old house, and tall mesquite.
	Water trough	29S	16W	10	NW¼ of SW¼	Open metal tank; apparently water is trucked.
Corbett	Windmill	29S	16W	15	SE¼ of SW¼	

Appendix 32

A partial plant list of the Peloncillo Mountains

Trees, shrubs, half-shrubs

Scientific Name	Common Name
Acacia constricta	White thorn
Acacia greggi	Catclaw
Agave parryi	Mescal
Alnus oblongifolia	New Mexican alder
Arctostaphylos pungens	Manzanita
Berberis trifoliolata	Algerita
Celtis reticulata	Netleaf hackberry
Cercocarpus montanus	Mountain mahogany
Chrysothanus sp.	Rabbit brush
Dasylirion wheeleri	Sotol
Ephedra viridis	Mormon tea
Fallugia paradoxa	Apache plume
Fraxinus velutina	Velvet ash
Garrya wrightii	Silktassel
Gutierrezia sarothrae	Broom snakeweed
Juglans major	Arizona walnut
Juniperus deppeana	Alligator juniper
Juniperus monosperma	One seed juniper
Koeberlinia spinosa	Spiny allthorn
Lycium pallidum	Pale wolfberry
Nolina microcarpa	Sacahuista
Pinus cembroides	Mexican piñon
Pinus chihuahua	Chihuahua pine
Pinus latifolia	Apache pine
Pinus reflexa	Southwestern white pine
Platanus wrightii	Arizona sycamore
Prosopis juliflora	Common mesquite
Quercus grisea	Gray oak
Quercus hypoleucoides	Silverleaf oak
Quercus oblongifolia	Mexican blue oak
Quercus reticulata	Netleaf oak
Rhus microphylla	Little-leaf sumac
Rhus trilobata	Skunk-bush sumac
Robinia neomexicana	New Mexican locust
Rosa neomexicana	Rose
Tamarix pentandra	Salt cedar
Yucca baccata	Datil yucca
Yucca elata	Soaptree yucca

Grasses

Andropogon scoparius	Little bluestem
Aristida longiseta	Red threeawn
Aristida purpurea	Purple threeawn

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Appendix 32 (cont'd.)

Grasses (cont'd.)

Bouteloua curtipendula	Sideoats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Bouteloua hirsuta	Hairy grama
Bouteloua radicosa	Purple grama
Eragrostis mexicana	Love grass
Lycurus phleoides	Wolftail
Muhlenbergia emersleyi	Bullgrass
Muhlenbergia montana	Mountain muhly
Muhlenbergia porteri	Bush muhly
Muhlenbergia rigens	Deer grass
Panicum hallii	Panic grass
Sitanion hystrix	Bottlebrush
Sporobolus contractus	Spike dropseed
Sporobolus crytandrus	Sand dropseed
Stipa neomexicana	New Mexican needlegrass

Forbs

Achillea lanulosa	Yarrow
Castilleja integra	Paint-brush
Lepidium virginicum var. *medium*	Pepper grass
Penstemon barbatus	Beardtongue
Solanum spp.	Nightshade
Sphaeralcea incana	Globemallow
Verbena wrightii	Verbena

Appendix 33

Water sources located in the Peloncillo Mountains

Name	Type	Township	Range	Section	Location	Comments
Mineral Mtn.	Windmill	24S	21W	21	SW$\frac{1}{4}$ of SW$\frac{1}{4}$	
Blue Mtn.	Windmill	25S	21W	13	NW$\frac{1}{4}$ of SW$\frac{1}{4}$	
Blue Mtn.	Tank	25S	21W	13	NW$\frac{1}{4}$ of SW$\frac{1}{4}$	
Section 33	Windmill	25S	21W	33	NW$\frac{1}{4}$ of NW$\frac{1}{4}$	
Richardson	Windmill	25S	21W	26	NW$\frac{1}{4}$ of NE$\frac{1}{4}$	
Cowboy Pass	Well	26S	21W	10	NE$\frac{1}{4}$ of NW$\frac{1}{4}$	
Granddad	Windmill	26S	20W	30	NE$\frac{1}{4}$ of NW$\frac{1}{4}$	
Evans	Tank	27S	20W	32	NE$\frac{1}{4}$ of SW$\frac{1}{4}$	
Section 5	Tanks	28S	20W	5	SE$\frac{1}{4}$ of SE$\frac{1}{4}$	
Section 35	Tanks	28S	21W	35	NE$\frac{1}{4}$ of NE$\frac{1}{4}$	
Trail Creek	Tank	29S	21W	1	NE$\frac{1}{4}$ of SE$\frac{1}{4}$	
Walters	Tank	29S	20W	7	NW$\frac{1}{4}$ of NE$\frac{1}{4}$	
Maloney	Earthen stock tank	29S	21W	11	SW$\frac{1}{4}$ of SW$\frac{1}{4}$	
Mud	Spring	29S	20W	28	NW$\frac{1}{4}$ of NW$\frac{1}{4}$	
Cottonwood	Spring	29S	21W	29	NE$\frac{1}{4}$ of NE$\frac{1}{4}$	

Water sources located in the Peloncillo Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Maverick #2	Spring	30S	21W	1	SW¼ of SE¼	
Old Isaacs	Spring	30S	20W	17	NW¼ of SE¼	
Shorty Miller	Spring	30S	20W	5	SW¼ of SW¼	
Rock Cabin	Spring	30S	20W	4	SE¼ of SE¼	
Black Mtn.	Tank	30S	21W	11	NE¼ of NE¼	
Section 9	Springs	30S	20W	9	NW¼ of	
Juniper Basin	Tank	30S	21W	28	NE¼ of SW¼	
Lovett	Tanks	30S	21W	35	NE¼	
Woodchopper's	Spring	31S	22W	12	SE¼ of NE¼	
Walnut Creek	Tank	31S	21W	31	SE¼ of SE¼	
Clanton	Spring	32S	22W	18	SE¼ of NW¼	
Campground	Windmill	32S	21W	16	NE¼ of NE¼	
Maverick #1	Spring	32S	21W	6	NW¼ of NE¼	At head of Cloverdale Creek
Lower	Spring	33S	21W	23	SW¼ of NE¼	
Middle	Spring	33S	21W	16	SE¼ of NE¼	
Indian	Spring	33S	21W	18	SW¼ of NE¼	
Little Bunk Robinson	Spring	33S	22W	23	NW¼ of SE¼	Drains into Baker Canyon.

Water sources located in the Peloncillo Mountains (cont'd.)

Name	Type	Township	Range	Section	Location	Comments
Guadalupe	Spring	33S	22W	12	NE¼ of NW¼	At head of Guadalupe Canyon.
Bunk Robinson	Spring	34S	22W	24	NW¼ of SE¼	Drains into main Guadalupe Canyon.
Springs of Contention	Spring	34S	21W	6	SW¼ of SW¼	
Springs of Contention	Spring	34S	21W	6	SE¼ of SW¼	
South Fork Guadalupe	Spring	34S	22W	13	SW¼ of SE¼	

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